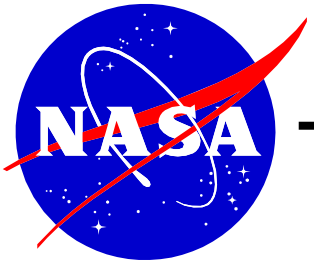
Gamma Ray Large Area Space Telescope (GLAST) Project Mission

RAPID II Satellite Delivery Order

Attachment A

Statement of Work

August 30, 2002



GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

Gamma Ray Large Area Space Telescope (GLAST) Project Mission

RAPID II Satellite Delivery Order

Attachment A

Statement of Work

August 30, 2002

NASA Goddard Space Flight Center

Greenbelt, Maryland

CHANGE RECORD PAGE

DOCUMENT TITLE: Gamma Ray Large Area Space Telescope (GLAST) Project Mission RAPID II Satellite Delivery Order, Attachment A, Statement of Work

DOCUMENT DATE: August 30, 2002

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CH-04	10/16/03	ii, 24 and 25.	CCR 433-0185.
CH-05	12/16/03	ii and 39.	CCR 433-0213.
CH-06	01/15/04	ii and 1.	CCR 433-0216.
CH-07	06/10/04	ii and 40	CCR 433-0234
CH-08	07/16/04	ii, 26 and 28	CCR 433-0232R2, 433-0245 and 433-0246
CH-09	9/20/04	ii and 41	CCR 433-0268

1.0 Introduction

NASA Goddard Space Flight Center (GSFC) is partnering with the Department of Energy (DOE), NASA Marshall Space Flight Center, Stanford University's Linear Accelerator Center, Stanford University, the Naval Research Laboratory, University of California, Santa Cruz, the University of Alabama, and several foreign partners to perform the Gamma-ray large area Space Telescope (GLAST) mission. The instruments aboard the GLAST Observatory will detect and investigate the direction, energy, and arrival time of gamma rays and gamma ray burst events. GSFC has the responsibility for overall project management, including procuring the Spacecraft and support services to meet the mission requirements as specified herein.

This Statement of Work (SOW) defines the contractor's efforts required in support of the GLAST Mission, which include providing a qualified spacecraft, integrating the Large Area Telescope (LAT) and GLAST Burst Monitor (GBM) instruments (provided as Government Furnished Equipment (GFE), conducting an observatory level verification testing program, and supporting launch and activation.

The GLAST Observatory will be launched from the Cape Canaveral Air Force Station, Florida, by February 2007, on a Government-provided Launch Vehicle (LV). The performance and interface requirements for the GLAST spacecraft are provided in Section 3.0 "Contract Documentation". CH-06

2.0 Scope

The contractor shall furnish all necessary personnel, facilities, services, and materials to design, fabricate, integrate, test, and support launch and activation activities for the GLAST Observatory under this Delivery Order (DO). This work shall be performed in accordance with the requirements of this document and all attachments to the GLAST DO.

In accomplishing the development and delivery of the GLAST Observatory, the contractor shall:

1. Provide a qualified Spacecraft, per the GLAST requirements.
2. Receive the LAT Instrument, GBM Instrument, and related Ground Support Equipment (GSE), then integrate the instruments with the Spacecraft and perform Observatory level testing.
3. Provide all required Spacecraft and Observatory mechanical and electrical GSE**.**
4. Have the appropriate licenses and be capable of receiving, handling, and storing all Gamma radiation sources necessary for GBM testing during I&T. The offeror shall work with the GBM instrument team to define the necessary tests and radioactive test sources, and perform all activities required to handle those sources.
5. Perform combined Observatory testing, ground system compatibility testing,

space segment compatibility testing, and pre-launch end-to-end testing with GSFC personnel and support from LAT instrument, and GBM instrument personnel.

6. Deliver the integrated Observatory, propellant, and support equipment to the launch site.
7. Support the LV mission integration process, launch base coordination and safety, Observatory and LV checkout, and launch in Government furnished facilities.
8. Provide all support services (e.g. - engineering, management, training, etc.) associated with launch, on-orbit observatory checkout, activation, and operations for 60 days.

For the above listed item number 8, contractor-provided support is defined to include: providing test plan comments and review; performing any contractor-provided equipment set-up required in the execution of the tests, and any other tasks required by this DO. The government will be directing and managing the tasks.

3.0 Contract Documentation

The documents listed in the Request For Offer, List of Attachments, with the exception of Attachment G. GLAST Mission Operations Concept Document, apply directly to the performance of the DO. These documents establish detailed specifications, requirements, and interface information necessary for the performance of this DO. Attachment G. GLAST Mission Operations Concept Document is for reference only. Documents listed in the Request For Offer, List of Attachments which identify standards reference the specific standards for compliance.

4.0 Work to be Performed by the Contractor

4.1 System Implementation

The effort to produce a specified core spacecraft, with the selected options, and the mission-unique modifications required in the DO, shall result in a product called the "Spacecraft". The effort to integrate and qualify the combined Instruments (consisting of the LAT and GBM instruments) and Spacecraft in accordance with the documents specified in the attachments shall result in a system called the "Observatory".

4.1.1 Core System

The contractor shall design, develop, implement, test, and qualify a Spacecraft ready for LAT and GBM instrument integration, integrate the LAT and GBM instruments with the Spacecraft, qualify the resulting Observatory, support GLAST mission tests, provide launch and operations support, and comply with all GLAST mission requirements in the documents specified in section 3.0, Contract Documentation**.**

4.1.2 Core System Option(s)

Intentionally left blank.

4.1.3 Mission-Specific Modifications

In order to meet the GLAST Mission requirements, as defined in the attached documents, the contractor shall modify their Spacecraft (core system), as necessary.

4.2 Non-Standard Services

Intentionally left blank.

4.2.1 Non-Mission-Specific Non-Standard Services

Intentionally left blank.

4.2.2 Non-Mission Specific Hardware

Intentionally left blank

4.2.3 GLAST Specific Non-Standard Services

The purpose of non-standard services ordered under this section shall be directly related to the GLAST mission under the delivery order. Requirements for the services are described in the GLAST RFO and DO.

Non-standard services ordered during the GLAST DO may be for the following types of efforts:

a) Special studies,
b) Analysis,
c) Anomly Resolution,
d) Services and Facilities in support of Resident Offices, as described in Section 4.2.3.2.

4.2.3.1 Special Studies, Analyses, and Anomaly Resolution

The contractor shall perform special studies/task assignments relating to the development, implementation, characterization, qualification, and operation of the GLAST Observatory, as authorized by the Government and in accordance with contract clause I.A.1 - RATES FOR NON-STANDARD SERVICES (modified to included special studies, rates, and ordering procedures for the GLAST mission as specified in Attachment M).

Additionally, the contractor shall perform task assignments relating to the analysis and resolution of on-orbit Observatory anomalies as authorized by the Government and in

accordance with contract clause I.A.1 - RATES FOR NON-STANDARD SERVICES (modified to included special studies, non-flight hardware or software end items (e.g., engineering models) rates, and ordering procedures for the GLAST mission as specified in Attachment M.

4.2.3.2 Resident Office Services and Facilities

The contractor shall provide dedicated office space, phones, furniture, copier(s), facsimile machine(s), computer with Microsoft Office and internet access, and facilities for three (3) resident and nine (9) visiting NASA and GLAST Project representatives at spacecraft assembly/test and Observatory integration and test at their facilities, as needed, for:

1. Spacecraft manufacturing activities;
2. Spacecraft and Observatory integration and test.

In addition, temporary accommodations shall also be provided on an as needed basis during spacecraft manufacturing and Observatory level integration activities.

These facilities are required to support the government insight team and the LAT and GBM instrument integration and test teams throughout the GLAST DO and may include both resident and visiting representatives. The offeror shall propose a phased plan for providing these services and services keyed to the program plan and schedule.

4.2.3.3 Electronic Distribution

To the maximum extent practical, the contractor shall distribute CDRLs and other GLAST documentation to the GLAST Project Office electronically and in a format mutually agreed upon.

The contractor shall provide a web-based, password-protected, ITAR compliant capability to facilitate the communication of information between the contractor and the integrated GLAST Project Team. At a minimum, deliverable information, including weekly and monthly technical and programmatic information (other than cost information), generated during the GLAST DO shall be placed on this web-based facility.

4.2.3.4 Video Conferencing

The contractor shall provide a video conferencing capability. The contractor shall conduct videoconferences with the GLAST Project Office and other parties as requested.

4.3 Standard Services

Upon receipt of the GLAST DO, the contractor shall provide all facilities, services, and personnel necessary for the successful and on-time implementation of all of the efforts necessary to meet the GLAST DO requirements.

4.3.1 Program Management

The contractor shall provide a program management function that is responsible for the control of the GLAST effort. The contractor's Program Management function shall provide to the Government reporting and near real-time insight into program status, as well as technical and programmatic performance of all of the contractor's responsibilities performed under the GLAST DO.

The contractor shall perform various design, study, trade-off and analysis tasks relating to the development, implementation, characterization and operation of the GLAST Observatory as necessary.

The contractor shall use their resource management system for planning, authorizing, and controlling resources and for providing timely and adequate visibility into manpower and schedule performance.

The contractor shall establish, implement, and maintain an integrated scheduling system consistent with their corporate procedures. The contractor shall provide to NASA timely updates of the master and detailed program phasing and milestone schedule. The contractor shall also provide observatory, spacecraft (subsystem), instrument (LAT & GBM) integration schedules.

The contractor shall provide the necessary resources for monitoring, controlling, executing, and administering the GLAST DO and subcontracts to ensure compliance with all contractual requirements.

The contractor shall be responsible for the rapid submission/negotiation of all change order proposals as required by this contract. Refer to CDRL, Engineering Change Proposals, Deviations and Waivers.

The items and services acquired under this DO are required to include accurate processing of the date and date-related data (including but not limited to calculating, comparing, and sequencing) by all hardware and software products delivered under this DO, individually and in combination, upon installation.

The contractor shall implement appropriate management systems that prevent the improper dissemination of government-provided competition sensitive and/or proprietary information.

4.3.1.1 Quality Management System

The contractor shall maintain and adhere to a Quality Management System that is compliant with the minimum requirements of ANSI/ISO/ASQ Q9001. Certificates issued to ISO 9001: 1994 will have a maximum validity of 3 years from the publication of ANSI/ISO/ASQ Q9001:2000.

4.3.1.1.1 Quality Assurance Requirements

The Spacecraft Mission Assurance Requirements (MAR), Attachment D defines supplemental requirements that shall apply to the DO.

The contractor shall prepare and provide the following documentation as described in the CDRL(s):

1. Observatory Contamination/Cleanliness Control Plan
2. Non-Conformance Reports
3. GIDEP Alert Responses
4. As-Designed/As-Built Parts, Materials, Processes, and Lubrications Lists
5. Parts Control Plan
6. Material Review Board Decisions on Non-Conformances
7. Failure Modes and Effects Analysis and Critical Items List
8. Probabilistic Risk Assessment
9. Fault Tree Analysis
10. Debris Analysis Report

4.3.1.1.2 Pre-Launch Reports

The contractor shall provide failure reports in accordance with company standards. However, these failure reports shall include risk rating of the problem in order to identify significant problems/failures. Contractor format, generation, review, disposition and/or approval of failure reports will be described in applicable procedure(s) included or referenced in the contractor's Quality Manual. Generated failure reports shall be provided to the government in a timely manner.

4.3.1.1.3 Post Launch Reports

Following launch, flight hardware and software anomalies, problems and failures shall be reported, in accordance with company standard, until the end of the on-orbit checkout period. The contractor shall demonstrate proper use of this reporting system prior to the Flight Readiness Review.

4.3.1.2 Documentation

The contractor shall develop, produce, deliver, and maintain all documentation required by the CDRLs and necessary to implement the GLAST DO. All efforts including the performance of tests and analyses not otherwise explicitly stated in other parts of this SOW, but determined jointly by the contractor and the government to be mission critical, shall be performed and documented by the contractor. All documentation, data, and analyses generated for, or applicable to, the effort, whether formal or informal, shall be made available to the government upon request at the contractor's facility.

The contractor shall prepare and provide Engineering Change Proposals (ECPs), deviations and waivers as described in the CDRL.

4.3.1.3 Reviews

The contractor shall conduct usual and customary internal reviews, including peer reviews, and provide for timely reporting of program status to the Government with discussions on problem areas, and a timely transfer of technical information to the Government, of major program milestones. The following program reviews shall be conducted, or supported, to certify Spacecraft or Observatory readiness.(Note: The Mission Design Review in the Rapid II Contract has been modified to be two different reviews: Spacecraft Preliminary Design Review and Spacecraft Critical Design Review.) CH-01

Review	Timeframe	Length (Days)	Location
Kick Off Meeting	ARO + 1 month	2	Contractor
System Requirements Review (SRR)	ARO + 3 months	2	Contractor
Spacecraft Preliminary Design Review (PDR)	ARO + 8 months	3	Contractor
Spacecraft Critical Design Review (CDR)	(TBP)	4	Contractor
Integration Readiness Review (IRR)	1 mo. prior to start of 1st Instrument integration	2	Contractor
Pre-Environmental Review (PER)	1 mo. prior to environmental tests	2	Contractor
Pre-Ship Review (PSR)	1 wk prior to ship	1	Contractor
Acceptance Review (AR)	10 days prior to Observatory handover	1	GSFC
Technical Interface Meetings Instrument interface meetings and peer reviews (for ICD development, resolution of technical issues, information exchange, etc.)	TBP	TBP	Instrument, SC contractor facilities, or GSFC
Monthly Program Status Review (MPSR) (held except when a major review is scheduled)	Monthly	1	Contractor
Weekly Status Teleconference	Weekly	2 hour	-----

CH-01

The government will chair all of the reviews, with the exception of the Kick Off Meeting, the System Requirements Review, and the Integration Readiness Review. Each review requires a review data package containing appropriate reference documentation for the

review. The minutes and action items that result from these reviews shall be documented by the contractor and made available to the government. If any deficiencies are found at the reviews, the contractor shall be required to develop a corrective action plan for the deficiencies prior to proceeding with the affected program development. At the beginning of each review all action items, collected at the previous review, shall be presented with the corrective action, or resolution, taken.

The GSFC/Code 301/System Review Office Design Review Program Guidelines can be found on-line at http://arioch.gsfc.nasa.gov/301/html/design.html

In addition to the above reviews, the contractor shall, at a minimum, provide support to the reviews/meetings listed below:

Review/Meeting	Timeframe	Length (Days)	Location
Ground System Interface Working Group Meetings	Starting January '04 thru launch, frequency TBP	2	Alternate Contractor and GLAST MOC contractor
Launch Vehicle Interface Meetings	(TBP)	(TBP)	(TBD)
Mission Preliminary Design Review	ARO + 8 months	2	GSFC
Instrument Pre-Ship Reviews	TBD	2	Each Instrument provider facility
Mission Operations Review (MOR)	L-21 mo. (TBR)	2	MOC, TBD
Operations Readiness Review (ORR)	L-6 mo.	2	MOC, TBD
Post-Ship Functional Verification Review	Prior to move to pad	1	Cape Canaveral, FL
Flight Readiness Review (FRR)	Launch – 1 week	1	Cape Canaveral, FL
Launch Readiness Review (LRR)	Launch – 1 day	1	Cape Canaveral, FL

CH-01

The LAT contractor is located in California. The GBM developer is located in Huntsville, Alabama.

Mission Operations Review (MOR): The objective of the MOR is to review the status of the system components, including the ground systems and its operational interfaces with the flight systems.

Flight Readiness Review (FRR): The objective of the FRR is to demonstrate that the

System is ready for flight. Ground and space segments must be demonstrated to be ready. Interfaces must be checked and functional. All factors must be addressed in constraints. Open items and waivers must be acceptable.
Operational Readiness Review (ORR): The objective of the ORR is to demonstrate that the deployed System is ready to perform the mission. The deployed System must be demonstrated to meet the mission requirements. The System must be proven ready to transition from the developers to the operators. Plans and procedures must reflect actual performance and operations.

4.3.1.3.1 Kick Off Meeting Requirements

The contractor shall review the plans, schedules, and activities required to meet the delivery order. It shall be based on the information detailed in the contractor's proposal and updated to reflect any changes since proposal submission, including the results of any contract negotiations and changes external to the DO. A network plan and schedule, including slacks and critical paths, for the total effort shall be baselined at this review and all updates shall be discussed at all subsequent reviews, including Program Status Reviews. The contractor shall present the technical proposal to the GLAST project and instrument personnel, and conduct a facility tour.

4.3.1.3.2 Systems Requirements Review

The contractor shall conduct a SRR describing how the contractor's requirements process, system engineering, concept for developing the LAT and GBM interface control documents, concept for accommodating the instrument interfaces, safety, quality, and reliability, and overall program plan meet the GLAST mission requirements. The contractor shall provide data for the SRR where mission requirements and subsystem requirements flow-down will be confirmed, based on the mini-proposal offered. The objective of this review is to assure that the objectives and requirements of the item being designed are understood and that the proposed approach will meet these requirements. The emphasis shall be on the requirements documented in the SRD, the MSS, the SPS, the IRDs, and other requirements documents, how they flow down and how they support the science objectives, and the definition of the major system interfaces. Detailed interfaces are to be presented at later reviews.

The completion of the Systems Requirements Review and the closure of any actions generated by the review shall become the basis for the start of the detailed design effort.

The design of the requirements database shall be described, including top-down and sideways consistency between requirements, (requirement traceability), verification of requirements and the capability of assessing the impacts of requirement changes and waivers.

The contractor shall provide, at a minimum, the following data and information.

1. Mission overview showing a mature understanding of the mission objectives and the approaches that will be used to carry out the mission together with the definition of roles and responsibilities
2. Quantitative estimates for the on-orbit environments
3. Mission performance requirements allocation and subsystem flow-down Resource allocations and margins (telemetry, commands, power, mass, data storage, processor capability, etc.)
4. Performance verification approach and rationale
5. Spacecraft bus integration and test sequence rationale
6. Observatory integration and test sequence and rationale
7. QA program applications, status, issues
8. Orbit, orbit maintenance, and flight dynamics analysis
9. Flight operations overview and status
10. Mission ground support equipment (GSE)
11. Mission Operations Training Simulator requirements for approval
12. I&T software requirements, description, status, verification
13. Flight software requirements, description, development, and verification plan, (preliminary), status
14. For each spacecraft subsystem, include
    a. Requirements flow-down
    b. Performance verification and validation approach
    c. Details of mission-specific elements
    d. GSE requirements

4.3.1.3.3 Spacecraft Preliminary Design Review (SC PDR) Requirements CH-01

The contractor shall conduct the SC PDR, prior to the preparation of formal design drawings. The SC PDR shall be held when the design is advanced sufficiently to begin some breadboard testing and /or the fabrication of design models. Detail designs are not expected at this time, but system engineering, resource allocations and design analyses shall demonstrate compliance with requirements. CH-01

A presentation of the design and interfaces by means of system-level diagrams, block diagrams, , signal flow diagrams, schematics, logic diagrams, error budgets, link margins, first interface circuits, packaging plans, configuration and layout sketches, analyses, modeling and any early results are required. Estimates of weight, power, volume (as applicable to demonstrate that the observatory fits within the launch vehicle) and the basis for the estimates of these parameters are required. Supporting data and analyses for mechanical, power, thermal, and electronic design: load, stress, margins, reliability assessments, shall be shown. Software requirements, design, structure, logic flow diagrams, Central Processing Unit (CPU) loading, design language and development systems shall be specified. Parts selection, de-rating criteria, and radiation hardness, shall be included as part of the SC PDR presentation. The identification of single point failure modes needs to be assessed as well as critical design areas which may be life limiting. CH-01 CH-01

The SC PDR shall include the following items: CH-01

1. Science/Technical Objectives, Requirements, General Specification
2. Quantitative Estimates for the On-Orbit Environments
3. Closure of action items from SRR
4. Changes since SRR
5. Performance Requirements
6. Error budget determination
7. Weight, Power, Data rate, Commands, EMI/EMC
8. Interface Requirements
9. Instrument accommodations
10. Preliminary ICDs
11. Design and analysis of all GLAST Spacecraft Bus subsystems including, but not limited to the following:
    a. Mechanical/structural design, analyses, and life tests
    b. Power, Electrical, thermal, optical/radiometric design and analyses
    c. Software requirements a design;
    d. Preliminary Interface Control Documents (ICDs)
    e. Ground Support Equipment design
    f. System Performance budgets
    g. Guidance Navigation & Control Design and Analysis
    h. Preliminary Pointing Budget Error Analysis
    i. Safehold Design and Analysis
    j. Command & Data Handling Design
    k. RF Design
    l. Propulsion
    m. Flight Software Design, Analysis, & Development Process
    n. Mission Operations Training Simulator
12. Spacecraft and Observatory design verification, test flow, calibration and test plans: qualification and environmental test plans and test flow at the box, subsystem, and system level
13. Observatory operations concept
14. Mission and ground system operations
15. Launch Vehicle interfaces and drivers
16. Component lists and flight heritage
17. Parts selection, qualification, and Failure Mode and Effects Analysis (FMEA) plans
18. EEE Parts Checklist
19. Contamination requirements and control plan
20. Quality Control, Reliability and redundancy
21. Reliability analyses results: FMEA, worst case analysis, FTA, and PRA
22. Materials and Processes
23. Acronyms and abbreviations
24. Safety hazards identified for flight, range, ground hardware and operations
25. Orbital Debris Assessment
26. De-orbit Strategy

27. Preliminary list of unique or additional telemetry points for monitoring de-orbit and anomaly resolution
28. Plans for shipping containers, environmental control and mode of transportation
29. Problem areas and open items
30. Schedules
31. Risk status, Analysis, and mitigation
32. Specific Analysis and Margins
    a. Stress and dynamics
    b. Loads determination
    c. Communication links
    d. Thermal flight predictions
    e. Power balance (end-of-life and battery DOD)
    f. Data flow, storage, and loading
    g. Pointing budgets including attitude control simulation results
    h. Flight dynamics, orbit insertion, maintenance, disposal
    i. Radiation, EMC, ESD, magnetics
    j. Failure mode and effects update

The completion of the SC PDR and the closure of any actions generated by the review shall become the basis for the start of the detailed drafting and design effort and the purchase of parts, materials and equipment needed. CH-01

4.3.1.3.4 Spacecraft Critical Design Review (SC CDR) Requirements CH-01

The contractor shall conduct a SC CDR prior to significant procurement or fabrication activities on the Observatory structure, solar array deployable system, and any other design that is unique to the Observatory configuration. A significant procurement or fabrication activity may be initiated prior to SC CDR if it is on the schedule critical path and agreed to by the government. The SC CDR shall present a final detailed design using substantially completed drawings, analyses, and breadboard/engineering model evaluation testing to show that the design shall meet the final performance and interface specifications and the required design objectives. Changes required to the design from the Systems Requirements Review shall also be included. Final calculations for mechanical loads, stress, torque margins, thermal performance, radiation design and expected lifetime are to be presented. Final software requirements, software design, and updated system performance estimates shall also be presented. Parts selection, de-rating criteria, and screening results, and the results of the FMEA, FTA and PRA are to be presented. CH-01 CH-01

At a minimum, the SC CDR shall cover the following items: CH-01

1. Detailed subsystem design & analysis
2. System Budgets including updates to mass (including fuel), power, alignment budgets or total system performance, and a Delta V budget
3. Closure of action items from the SC PDR CH-01

4. Changes since SC PDR CH-01
5. Instrument accommodations
6. Spacecraft and Observatory modes, anomaly detection/autonomous response capability and compliance with all avoidance requirements
7. Traceability of requirements to design solutions
8. Risk management items, status, and mitigation plans
9. Pointing accuracy, knowledge, and system jitter analyses
10. Grounding and fusing definitions
11. Identification of special needs such as purge, cleanliness, sensor and instrument stimulus
12. Completed ICDs (check CDRL)
13. Flight software design, including high-level description of autonomous repointing algorithms
14. Final Command & Data Handling architecture implementation
15. Final RF architecture
16. Final implementation plans including engineering models, prototypes, flight units, spares, test and flight harnesses
17. Engineering model/breadboard test results and design margins, as appropriate.
18. Completed final stress and dynamics design analysis
19. Thermal flight predictions
20. Final attitude control system stability analyses
21. Final Guidance Navigation & Control architecture, including relevant de-orbit architecture
22. Propulsion, including relevant de-orbit architecture
23. Guidance, Navigation and Control performance simulations
24. Final Safehold implementation
25. Pointing budgets
26. Qualification/Environmental test plans and test flow at the box, subsystem and system level
27. Spacecraft and Observatory Integration and Test Plans
28. Launch vehicle interfaces
29. Contamination Control Plan
30. Observatory Ops concept and Missions Operations Requirements
31. Preliminary Command and Telemetry Handbook (check CDRL)
32. Reliability analyses results: FMEA, worst case analysis, FTA, PRA
33. Mechanical, Electrical, and GLAST-unique ground support equipment
34. Plans for shipping containers, environmental control and mode of transportation
35. Problem areas/Open items
36. Schedules

4.3.1.3.5 Integration Readiness Review (IRR) Requirements

The contractor shall conduct an IRR. Successful completion of the IRR shall result in concurrence that the Spacecraft performance is adequate for the beginning of the Instrument integration process. All procedures required for integration shall be released or ready for release at the IRR.

At a minimum, the following information shall be presented:

1. Results of the latest Spacecraft comprehensive performance test
2. Changes since MCDR
3. Closure of action items from MCDR
4. GSE functionality
5. Resolution plans for all failures, anomalies, and malfunctions encountered during component and system testing
6. Remaining open integration issues and their proposed resolution
7. Readiness to perform Instrument integration (e.g. staffing, facilities, GSE, procedures, resources, etc.)
8. Plans to proceed to PER (tests, activities, facilities, resources, schedule, flow)
9. I&T software readiness and verification status
10. Present a final (as performed) verification matrix addressing qualification down to the component level of assembly
11. Flight software development and verification status
12. Risk status

4.3.1.3.6 Pre-Environmental Review (PER) Requirements

The contractor shall conduct the GLAST PER to review all hardware and software test configurations, test plans, procedures, facilities and responsibilities to ensure that the environmental testing will proceed in a controlled manner and that all the necessary requirements and procedures are documented and understood. The PER shall be considered complete upon satisfactory closeout of PER action items critical to proceeding with testing.

At a minimum, the contractor shall present the following at the PER:

1. Closure of action items from IRR
2. The results of the Instrument integration and the status of the Observatory development and test
3. A resolution plan for all failures, anomalies, and malfunctions encountered during the Instruments' integration
4. Status against GLAST ICDs and margins
5. Status of Spacecraft GSE instrumentation and environmental test facilities
6. Review of all environmental test plans and procedures
7. The detailed thermal vacuum and thermal balance test plans showing the Observatory in the chamber, the hot and cold plates and shrouds, test targets, RF coupling, test simulators, QCMs, cold finger, planned test profile, tests performed at the plateaus and transitions, cleaning and outgassing plan with analysis support from the Instrument teams
8. The Observatory phasing (end-to-end polarity) verification plans and status
9. The structural qualification/acceptance plan, showing the final modal analyses and coupled loads analyses results.

10. Definition of the predicted test limits for the components of the Spacecraft and Instruments (with analysis support from the Instrument teams) for:
    a. Dynamic Testing
    b. Thermal-Vacuum/Thermal Balance
11. Verification that the planned test environments adequately demonstrate the Observatory performance requirements without presenting a hazard, and without degrading Observatory performance and lifetime by analysis to compliance with the GLAST Specifications and ICDs.
12. The plans to proceed to Observatory PSR (e.g. tests, activities, facilities, staffing, resources, schedule, flow).

4.3.1.3.7 Operations Readiness Review (ORR)

The contractor shall conduct the GLAST ORR to verify and document that the Observatory, Instruments, operations system, and flight and ground software are performing in accordance with the GLAST requirements. The ORR shall be considered complete upon satisfactory closeout of all ORR action items.

At a minimum, the contractor shall present the following at the ORR:

1. Detailed plans of the launch support (e.g. activities, facilities, staffing, resources, schedule, and flow).
2. Contractor's assessment of the readiness of flight operations procedures.
3. Ground network compatibility and Space Network (SN) compatibility RF test results and open issues with plan for closure.
4. Overview of mission & launch simulations plans.

4.3.1.3.8 Pre-Ship Review (PSR) Requirements

The contractor shall conduct the GLAST PSR to verify and document that the Observatory, Instruments, operations system, and flight and ground software are performing in accordance with the GLAST requirements. The PSR shall be considered complete upon satisfactory closeout of all PSR action items.

At a minimum, the contractor shall present the following at the PSR:

1. Closure of action items from PER.
2. Results of all the environmental tests, end-to-end tests, and the latest Observatory comprehensive performance test and comparison against requirements.
3. A resolution plan for all failures, anomalies, and malfunctions remaining open.
4. Flight software verification results.
5. Any remaining open issues under the DO and their proposed resolution.
6. Shipping plans and documentation status (e.g. shipping lists, manifests, containers, handling, transport, etc.).
7. Observatory documentation status (e.g. final configuration lists, trend data, test reports, mass properties, system safety plan, life-limited items, equipment logs, cleanliness certification, and any other necessary documents).
8. Receiving point plans - arrival time and place, storage, handling, points-of-contact, mechanical and electrical test plans and procedures.

9 Detailed plans of the launch support (e.g. activities, facilities, staffing, resources, schedule, flow).

4.3.1.3.9 Acceptance Review (AR)

The contractor shall conduct a 1 day AR, no earlier than 10 days prior to Observatory hand-over, to verify and document that the Observatory and its interfaces are performing in accordance with the GLAST SPS and ICDs, and that all other requirements under this DO have been completed. The AR shall be considered complete upon satisfactory closeout of all critical AR action items.

As a minimum, the contractor shall present the following at the AR:

1. Results of on-orbit activities.
2. Closure of action items from ORR
3. Modifications of flight operations procedures and other documentation.
4. Status/update of all configuration managed items.
5. Status and resolution plan for all failures, anomalies, and malfunctions.
6. Observatory documentation status (e.g., nonconformance reports and the Observatory On-orbit Performance Report).
7. Any additional material/data required to support completion of all contractor proposed final milestone completion criteria.

4.3.1.3.10 Monthly Program Status Review (MPSR) Requirements

The contractor shall conduct GLAST MPSRs to review project status in terms of schedule, technical issues, performance (and margin), manpower, and to identify problem areas and assign action items for their solution. To save time and travel, these meetings should be combined with other reviews, videoconferences, or teleconferences at the discretion of the Government. The offeror shall submit the minutes of these meetings with a copy of the review handouts as the monthly status report.

The contractor shall present the following information at the MPSR:

1. Status of work being performed including appropriate metrics.
2. Detailed status of schedule and integrated project schedule.
3. Status of project staffing and any shortages.
4. Milestone Monitoring - The contractor shall report on the status of progress made toward accomplishing each of his major milestones. Each report shall include a listing of major accomplishments and a discussion of any problems associated with each milestone as well as their resolution.
5. Status of technical issues and risks.
6. Changes to design parameters such as mass, power profile, communications, system performance, etc.
7. Resource allocations and margins (telemetry, commands, power, mass, data storage, processor capability, etc.)

8. Margins as a function of time and design maturity; track the resource against the budget
9. Descriptions and status of technical problems and the resolutions.
10. Subcontract technical performance, manpower resources, schedule, and milestone status.
11. Performance assurance status including non-conformance reports and failure report dispositions.

4.3.1.3.11 Weekly Status Teleconference

The contractor shall conduct Weekly Status Teleconferences throughout the DO. A Weekly Status Teleconference is not required during the week that a MPSR is held. The contractor shall address the following topics at a minimum in the teleconferences:

1. DO activities, plans, and progress against those plans.
2. Review of calendar of upcoming meetings, events, and previous actions.
3. Communications and Correspondence.
4. Descriptions and status of technical problems and the resolutions.
5. Status of technical issues and risks.
6. Performance assurance status including non-conformance reports and failure report dispositions.
7. Issues and Action Items.

4.3.1.4 Government Insight

All contractor and subcontractor internal data, reviews, audits, meetings and other activities pertinent to the execution of the contract shall be open to government review/attendance. The contractor shall provide the government with reasonable and timely notification, to facilitate government attendance. Government support contractors may also attend these reviews, audits, and meetings at the government's discretion.

The contractor shall ensure that all information required for the NASA Software Independent Verification and Validation (IV&V) effort is made available to NASA IV&V personnel via the GLAST Project IV&V Liason. Wherever possible, the contractor shall permit electronic access to the required information. The contractor shall allow NASA IV&V review and participation before final product delivery to the Government.

> (Government insight is defined as gaining understanding necessary to knowledgeably concur with the contractor's action through watchful observation, inspection, or review of program events, documents, meetings, tests, audits, hardware, etc., without approval/disapproval authority. Where Government insight is required, the contractor shall notify the Contracting Officer, the Government Resident Office or the appropriate Government operations organization of meetings, reviews or tests in sufficient time to permit meaningful Government participation.)

4.3.1.5 Audit

The contractor shall support government audits of processes, products, documentation and data in order to provide assurance to the government that the program is being implemented according to all requirements and specifications. The contractor's documentation of standard policies and procedures compliant to ANSI/ISO/ASQ Q9001 shall be available for inspection at all reviews, audits, and meetings at the contractor's facility.

4.3.2 Systems Engineering

The contractor shall perform the necessary systems engineering required to ensure that the spacecraft, options, and modifications meet all of the performance, interface, and implementation requirements of the GLAST DO. The systems engineering effort shall comprise the analysis of technical requirements, allocation of derived system, spacecraft bus, ground system, and lower level requirements, definition and maintenance of interfaces, verification of all defined and derived requirements, risk management, and tradeoff analyses. The systems engineering effort shall be on-going through all stages of the GLAST program, including the allocation of the system performance specification, design, development, fabrication, qualification and acceptance testing, launch operations, post launch checkout, on-orbit anomaly resolution, integration into the science and operational systems, and mission operations. The contractor shall perform a fully integrated systems engineering management effort, including, but not limited to, the following:

1. Providing technical direction and oversight throughout all phases of the program.
2. Supporting reviews as defined in section 4.3.1.3. The support shall include responsibility for the preparation of responses to all action items to the contractor during the reviews.
3. Attending and supporting LAT and GBM instrument reviews and meetings at the instrument facilities or NASA/GSFC.
4. Conducting interface working group meetings
5. Performing all necessary system studies, trades, and risk assessments determined jointly by the contractor and NASA to be necessary to meet the mission requirements as defined in the GLAST specifications.
6. Configuration management;
7. Risk management;
8. Peer reviews;
9. End-to-end systems engineering;

4.3.2.1 Requirements Analyses and Allocations

The contractor shall conduct complete analyses of the observatory requirements which fully establish, define, maintain, and control resource allocations. Traceability of the requirements flowing down from the SRD and the MSS to lower levels, as well as the

consistency of the requirements allocated to various subsystem elements, shall be established. Budgets shall be established for mass and mass properties, angular momentum, disturbance torque, power, radio frequency transmission channels, alignment, pointing control, pointing knowledge, pointing stability, on-board processor resources, and propellant capacities. Margins for each resource shall be established and a plan for eroding the margin as a function of time and design maturity metrics for tracking the resource against the budget shall be maintained and reported monthly. The contractor shall provide mass and power estimates at the box level which identify contingency and margins per ANSI/AIAA G-020-1992 "Estimating and Budgeting Weight and Power Contingencies for Spacecraft System" or equivalent contractor system. The contractor shall give rationale and reason for any deviations from recommended contingencies and margins as specified by the ANSI/AIAA G-020-1992 "Estimating and Budgeting Weight and Power Contingencies for Spacecraft System, using the power and budget templates provided in the Attachments as format guides. Selection of component class shall be appropriate to the level of development of the individual component, and is not restricted by the stage of the Program. The contractor shall maintain appropriately updated index of analyses and allocations. The contractor shall make the results of all analyses available for Government review at each subsequent major program review. Tasks include, but are not limited to, the following:

1. Verifying the GLAST operations concepts and perform the launch-to-orbit and in-orbit mission analyses required to verify the operations of the Observatory.
2. Conducting the analyses required to confirm the integrity of the GLAST design to ensure the performance requirements of the applicable specifications will be met over the Observatory specified mission end-of-life.
3. Conducting the analyses required to verify that the spacecraft provides the interface and environment necessary for the LAT and GBM instruments to meet their functional and performance requirements.
4. Performing and maintaining RF link calculations.
5. Providing the telemetry and command handbook in accordance with the GLAST DO.

4.3.2.2 Interface Definition, Verification and Control

Using the results of the analyses and allocations of technical parameters performed in support of the efforts described in section 4.3.2.1, the contractor shall specify, with agreement by the government, all interfaces not explicitly defined by government specifications. These interfaces shall then be defined, documented, verified, and controlled for the duration of the contract, by the contractor and approved by the government.

The contractor shall prepare a Mission Performance Verification plan in accordance with the GLAST DO. The contractor shall document external Interfaces, Models, and Analysis, and the Telemetry and Command implementation in accordance with the GLAST DO.

4.3.2.2.1 Instrument Interfaces

The contractor shall perform systems engineering and analysis in support of designing, documenting, and implementing all interfaces between the Spacecraft subsystems and the Instruments, and Spacecraft GSE-to-Instrument GSE. This support shall include the following:

1. Developing, and maintaining configuration management of, the Spacecraft-Instrument interface control documents for the LAT and GBM, in accordance with the CDRL.
2. Addressing LAT and GBM Instrument accommodations and status as part of each Spacecraft review.
3. Identifying cognizant engineer(s) responsible for the LAT and GBM Instrument interfaces.
4. Providing technical support for interface design, documentation, and verification.
5. Performing mechanical, thermal, electrical, power, contamination, radiation shielding, and other analyses as necessary to ensure Spacecraft to Instrument (LAT and GBM) compatibility.
6. Attend key LAT and GBM reviews prior to Instrument deliveries.

The contractor shall build, test, deliver, and integrate all GBM flight and test harnesses, as required in the GBM IRD and Attachment L-Deliverables. The contractor shall document the details of the flight and test harnesses in the Spacecraft-GBM ICD.

The contractor shall develop, maintain and provide all technical and programmatic documentation required to ensure successful Observatory integration.

The government will supply reduced instrument Thermal Math Models (TMM's) to the spacecraft contractor for use in designing the Spacecraft-Instrument interfaces. The contractor shall combine the instrument model with the spacecraft analytical model to create a system level Observatory thermal model. The Observatory TMM shall be used for both the design of the instrument interfaces with the Spacecraft, and to demonstrate compliance with the interface requirements. Additionally the Observatory TMM shall be used to provide design thermal analyses for all mission phases including launch and ascent, nominal operations, survival and any other additional significant Observatory operating modes.

The contractor shall create a table of environmental backloads, absorbed heat loads, and temperatures with the Observatory model for distribution to the Instrument teams. The purpose of this activity is to assure that the two thermal models are consistent. This process is iterative and shall be provided to the instrument teams one month prior to PDR, CDR, PER, and PSR, per the requirements specified in the Spacecraft Mission Assurance Requirements. The Observatory TMM shall be used to provide temperature predictions through every phase of the mission, launch and ascent, nominal ops, survival and any additional significant Observatory modes. Predictions are to be based on worst CH-01

case stacking of parameters in bounding the design, e.g. Beginning of Life (BOL) predictions with cold orbital environments and minimum power dissipations, End of Life (EOL) predictions with hot orbital environments and maximum power dissipations.

NASTRAN Finite Element Models (FEMs) of each instrument will be supplied by the government for use in designing the Observatory. The finite element models shall be in NASTRAN format and use the SI system of units. The contractor shall combine the instrument FEMs with the Spacecraft FEM to form a combined comprehensive Observatory FEM for launch and on-orbit configurations, and shall provide the Observatory FEM to the government for coupled loads analyses by the LV provider. After completion of the coupled loads analysis, the government will provide the results of the coupled loads analysis to the contractor. The contractor shall provide to the government the instrument-related results from the coupled loads analysis. The government will then provide appropriate information to the instrument teams relating to launch loads.

4.3.2.2.2 Observatory to Ground and Space Segment Interfaces

The contractor shall prepare an Observatory to Ground Station ICD(s) in accordance with the CDRL. This ICD(s) provides the details of all interfaces between the ground sites used to communicate with the GLAST spacecraft. The contractor shall optimize the Observatory to ground interface to allow for efficient operation of GLAST.

The contractor shall prepare an Observatory to Space Resource ICD(s) in accordance with the CDRL. This ICD provides the details of all interfaces between the Observatory and the space-born resources required to achieve the GLAST mission. Currently the only resources in this category are the GPS constellation and the TDRSS. No other space-borne resources will be required by the GLAST mission.

The contractor shall support the government in the preparation of a variety of ICDs associated with the government-provided Mission Operations Center. The interfaces include but are not limited to:

1. MOC to GN
2. MOC to SN
3. MOC to Launch Site
4. MOC to GCN
5. MOC to GBM IOC
6. MOC to SSC
7. MOC to LAT IOC
8. MOC to Spacecraft Fabrication Facility

The contractor shall provide all necessary documentation for the ground command, control and data system associated with GLAST. This is to include all necessary system documentation, interface control documents, databases and test efforts.

The contractor shall perform all analyses and tests, required to ensure proper operational compatibility between the Observatory and the government-provided ground segments. The contractor shall develop, maintain, and provide all technical and programmatic documentation required to ensure successful operation of the Observatory including, but not limited to, the requirements outlined in the CDRLs.

4.3.2.2.3 Observatory to Launch Vehicle (LV) Interface

The contractor shall define and maintain all design interface information between the Observatory and the Government provided launch vehicle. The contractor shall submit launch vehicle documentation in accordance with the CDRL. The contractor shall participate in the preparation and maintenance of the Observatory-to-launch vehicle ICD. The responsibility for writing, maintaining, and gaining approval of this ICD will reside with the government. The contractor shall develop, maintain, and provide all technical and programmatic documentation required to ensure a successful launch activity. This includes all Observatory level safety-related documentation as required by the launch site and launch range organizations. The government will provide all necessary safety information relative to the LAT and GBM to the contractor for incorporation in these documents. The contractor shall submit the missile systems pre-launch data package (MSPSP) in accordance with the CDRL(s).

Prior to the final flight mate to LV interfaces, the contractor shall perform a flight ready mechanical fit check and an electrical interface verification test of the Observatory. The mechanical fit check and electrical interface verification test shall be performed at the contractor's location prior to shipment to the launch site. The government (or launch services provider) shall supply a test payload attach fitting which simulates the LV side of the interface.

The contractor shall provide the analytical models and shall perform all analyses and tests required to ensure proper electrical, mechanical, thermal, and operational compatibility between the Observatory and the government-provided LV and LV environments. The government, through the launch service provider, will provide for 4 cycles of Coupled Loads Analysis. The contractor shall develop, maintain, and provide all technical and programmatic documentation in accordance with the CDRL.

4.3.2.3 Design and Performance Verification Analyses

The contractor shall perform and document all analyses of the data and information from all testing, including but not limited to, the design, qualification testing, acceptance testing, compatibility testing, on-orbit testing of the contractor's hardware and software which are required to ensure that the program will meet its specifications and objectives.

4.3.2.4 Safety

The contractor shall plan and conduct a system safety program for the Observatory that accomplishes the following:

- Provides for the identification and control of hazards to personnel, facilities, support equipment, and flight systems during all stages of project development and integration. The program shall also consider hazards in the flight hardware, software, associated equipment and potential malfunctions in Instrument GSE that may affect the Spacecraft or the LV.

- Satisfies the applicable guidelines, constraints, and requirements stated in the revision version of the EWR 127-1 in effect at the time of contract award, Eastern and Western Range Safety Requirements.

- Interfaces effectively with the industrial safety requirements of the contract and the Contractor's existing safety program.

The contractor shall provide Observatory level safety-related documentation as required by the launch site and launch range organizations in accordance with the CDRL(s).

The contractor shall also submit the Debris Generation Analysis Report in accordance with the CDRL(s).

4.3.3 Spacecraft

The contractor shall produce and verify a spacecraft that meets all of the requirements, specifications, and interfaces in accordance with the GLAST delivery order. Prior to integration with the LAT and GBM instruments, the spacecraft structural, thermal and electrical design shall be qualified, per the Spacecraft MAR, and verified by a combination of analyses and tests on engineering models, prototype or proto-flight hardware and software. Additionally, the spacecraft shall undergo a comprehensive performance test to demonstrate readiness for Observatory level integration.

4.3.3.1 Government Furnished Equipment

The government will deliver the government-furnished equipment (GFE) referenced in Attachment K.

4.3.4 Spacecraft and Observatory Integration and Test

The government will deliver the qualified LAT and GBM instruments to the contractor’s integration and test facility.

The contractor shall provide a receiving area for the LAT and GBM instruments at the GLAST Observatory integration and test facility and provide a suitable area with appropriate utilities for the instrument teams to unload, assemble, inspect, and checkout their instruments. Upon successful completion of these inspections and test the spacecraft contractor shall then assume responsibility for the handling and storage of the LAT and GBM instruments, and their associated mechanical and electrical GSE.

The contractor shall plan, manage, and execute an observatory level program to integrate and test all Spacecraft and Instrument hardware and software, including supporting compatibility testing with the ground system. This program shall be documented in a contractor prepared spacecraft and observatory integration and test plan in accordance with the CDRL(s). The Observatory shall be tested with calibrated and maintained GSE.

The contractor shall provide the Government two copies of all photographs and videotapes, or electronic equivalent, taken during integration, testing, and closeouts in accordance with the CDRL.

4.3.4.1.1 Ground Support Equipment and Simulators

4.3.4.1.1 Ground Support Equipment

The government will deliver the Instruments to the Observatory integration and test site and provide mechanical ground system equipment (MGSE), electrical ground system equipment (EGSE), and the instrument ground support equipment (IGSE) and software necessary to support the unique integration and testing of the instruments at the Observatory level. The contractor shall provide all other necessary mechanical and electrical ground support equipment needed to support Spacecraft-level and Observatory-level integration, environmental testing, and Observatory-level tests at the launch site. The electrical ground support equipment shall also include the Ground System used for sending commands, displaying telemetry, running automated procedures, and monitoring the health and safety of the Observatory. The contractor shall provide the accommodations for all instrument electrical and mechanical ground support equipment.

The contractor shall incorporate the database for each instrument into the Spacecraft database for observatory-level integration and test and ensure that the Spacecraft Ground System is capable of distributing instrument data to the instrument ground support equipment. The contractor shall also support the migration of the combined instrument and spacecraft database to the project database for mission operations.

The contractor shall negotiate need dates for delivery of all government furnished items such as math models, instrument simulators, etc.

4.3.4.1.2 Simulators

4.3.4.1.2.1 Spacecraft-Instrument Interface Simulators (SIIS) CH-04

The contractor shall design, fabricate, validate, and deliver a total of two Spacecraft – Instrument interface simulators to the instrument developers: one simulator to the developer of the LAT instrument and one simulator to the developer of the GBM instrument. The contractor shall provide Spacecraft-Instrument simulator operations support and user's documentation delivery of each simulator and, prior to LAT and GBM Instrument deliveries, during both LAT and GBM Instrument testing. Each of the CH-04 CH-04

Spacecraft-Instrument interface simulators that the contractor provides shall be maintained and updated by the contractor for the duration of the contract. CH-04

The fidelity of the Spacecraft-Instrument interface simulators shall be sufficient to validate all electrical interfaces between the Spacecraft and the instrument. The Spacecraft simulators shall provide power and permit high fidelity tests of the following interfaces: data bus for bi-directional command and telemetry, data bus for high-rate science data, timing bus, and discrete analog and digital services. The details of the Spacecraft-Instrument interface simulators and their interfaces shall be documented in the Spacecraft-Instrument ICDs. CH-04 CH-04

4.3.4.1.2.1.1 Spacecraft Data Interface Simulator (SDIS)

The contractor shall design, fabricate, validate, and deliver a total of two Spacecraft Data Interface Simulators to the instrument developers: one SDIS to the developer of the LAT instrument and one SDIS to the developer of the GBM instrument. The contractor shall provide Spacecraft Data Instrument Simulator operations support and user's documentation delivery of each simulator and, prior to LAT and GBM Instrument deliveries, during both LAT and GBM Instrument testing. Each of the Spacecraft Data Interface Simulators that the contractor provides shall be maintained and updated by the contractor for the duration of the contract. CH-04

The fidelity of the Spacecraft Data Interface Simulators shall be sufficient to validate all data (1553, Science Data, PPS, Discretes) interfaces between the Spacecraft and the instrument. The SDIS shall permit high fidelity tests of the following interfaces: data bus for bi-directional command and telemetry, data bus for high-rate science data, digital discretes and timing bus. The details of the SDIS its interfaces shall be documented in the Spacecraft-Instrument ICDs.

4.3.4.1.2.2 Instrument-Spacecraft Simulators

The contractor shall receive a total of two instrument simulators from the instrument developers: one simulator from the developer of the LAT instrument and one simulator from the developer of GBM instrument. The fidelity of the instrument simulators shall be sufficient to validate all electrical, data, and command interfaces between the instrument and the Spacecraft. The details of the Instrument-Spacecraft simulators and their interfaces shall be documented in the Spacecraft-Instrument ICDs.

Additionally, the contractor shall receive one, GBM power-supply load simulator. The details of the GBM power-supply load simulator and its interfaces shall be documented in the Spacecraft-Instrument ICDs.

The contractor shall support the government in defining an interface between the instrument GSE and the I&T Ground System.

4.3.4.1.2.3 Section Deleted

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4.3.4.1.2.4 MOC Training Simulator

The contractor shall develop a MOC Training Simulator that will be used for developing and verifying mission operation procedures, anomaly resolution, and training the mission operations team. The contractor shall provides all personnel, services, materials, facilities, software and hardware required to develop, deliver, install, and verify the GLAST Mission Operations Center Training Simulator. The Mission Operations Center is the primary link between the ground-receive sites and the science community as described in the Mission Operations Concept Document 433-OPS-0001.

The contractor shall develop, install, deliver and verify the GLAST Mission Operations Training Simulator. The contractor shall determine the MOC Training Simulator system and performance requirements and design a MOC Training Simulator in accordance with the requirements. The design shall include requirements analyses, appropriate software and hardware solutions to meet the requirements, and estimates of time and cost to implement and test the proposed system.

The contractor shall: assemble and integrate the hardware components of the MOC training simulator; create and install the necessary software; design, execute and present the results of tests on the training simulator to show the requirements are met. The contractor shall deliver the MOC Training Simulator to the MOC location specified by the government on the date specified and participate in the installation of the hardware and software on the delivered system.
The delivery shall occur in two phases as described in the GLAST RFO deliverable list. The first phase shall include items required for nominal operations simulations. The second phase shall include items that are required for simulating special one time events and contingency operations.

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The fidelity of the MOC Training Simulator shall be sufficient to perform all necessary mission simulations. Prior to delivery of the MOC Training Simulator, the contractor shall develop any LAT and GBM instrument software simulation tools and MOC interface simulations required to verify MOC Training Simulator interfaces and functionality. The contractor shall support the government ground system contractor with the integration of the government ground system contractor-provided Instrument simulators with the MOC Training simulator, and with the integration of the MOC Training Simulator into the MOC. The contractor shall provide the documentation in accordance with the CDRL. The contractors shall present a review of each build delivered to the MOC before it is installed on any system. The last of these shall be an acceptance review. The data contents of these reviews are described in the CDRL. This simulator shall be delivered to the organization responsible for mission operations for the project.

4.3.4.1.2.5 Spacecraft (SC) Simulator (Hot Bench)

The contractor shall develop a Spacecraft Simulator ("Hot Bench") that will be used by the contractor, at the contractor site, throughout the SC and Observatory development and test programs to perform validation of hardware/software interfaces, I&T test procedure validation, I&T anomaly resolution, GNC closed loop performance testing, and fault protection testing/validation not practically performed on the SC. The contractor shall provide all personnel, services, materials, facilities, software, and hardware required to develop, deliver, install, and verify the Hot Bench. The Hot Bench shall be delivered to the government, set up in their facility and functionally verified post Observatory acceptance.

The Hot Bench shall have sufficient fidelity to perform all necessary SC functions and shall meet the following requirements:

1. The Hot Bench shall incorporate Engineering Models (EM) of all C&DH boards including the spacecraft processor.
2. The Hot Bench shall accommodate EMs of the Electrical Power Subsystem components, and EM/Loaner Units for the GNC and Communication subsystem components.
3. The Hot Bench shall contain sufficient resources to host the entire flight software image.
4. The Hot Bench shall have the capability to verify all flight software uploads to the EM processors.
5. The Hot Bench shall communicate with the EM processors and command and telemetry interfaces with interfaces electrically equivalent to the spacecraft interfaces.
6. The Hot Bench shall use AstroRT to send commands to the spacecraft and display telemetry using the same command and telemetry databases used to develop the flight software and that are used for on-orbit operations.
7. The Hot Bench shall provide spacecraft dynamics software models that simulate the spacecraft operating environment, including position and velocity, attitude sensor input data, earth, sun and lunar position.
8. The Hot Bench shall provide attitude control sensor and actuator system software models.
9. The Hot Bench shall incorporate simulation of the SSR sufficient to simulate the command and telemetry functionality of the on-board recorder.
10. The Hot Bench shall generate representative science data at the representative rate.
11. The Hot Bench shall provide models of the instruments sufficient to emulate the command and telemetry functionality of the instruments.
12. The Hot Bench shall model the on-board processor redundancy.
13. The Hot Bench shall allow the configuration of simulated scenarios to be accomplished either manually or via scripts.
14. The Hot Bench simulation and initialization shall be controlled via configuration files that can be saved and edited.
15. The Hot Bench shall run in real time.
16. The Hot Bench shall accept user input for applying a failure mode while running in real time or as a pre-defined condition at the simulation start.
17. The Hot Bench shall include bus monitors to examine the traffic on the busses.

4.3.4.1.3 Large Area Pulsed Solar Simulator (LAPSS)

The contractor shall receive a large area pulsed solar simulator from GSFC. The LAPSS shall be capable of generating current vs voltage curves to assess the adequacy of the solar array for flight. The contractor shall have the use of the LAPSS for a period of four weeks. As part of the LAPSS, the contractor shall receive lamps, lamp housing, baffles, and a pulse forming network, which is the power supply for the lamps. Additionally, the contractor shall receive an active electronic load, passive loads, data acquisition equipment and procedures to run the test. GSFC personnel will operate the LAPSS equipment. The testing of the solar array with the LAPSS shall be done in addition to the baselined solar array verification program, including capacitance testing. CH-08

4.3.4.2 Integration

The contractor shall plan and conduct integration of the Spacecraft and instruments in accordance with the integration and test plan in the CDRL(s). The contractor shall develop integrated Observatory test procedures in conjunction with the instrument providers. The contractor shall develop the detailed test requirements in conjunction with the instrument providers as part of interface development and documentation. After instrument integration, all tests shall be conducted through the Spacecraft and its associated GSE (i.e., Spacecraft GSE to Spacecraft then to instruments). Real-time monitoring of instrument command and telemetry shall be made available to instrument analysts supporting the Observatory system level testing. As mutually agreed to, the contractor shall provide all instrument test data, in a mutually agreed upon format and media, after completion of testing.

4.3.4.3 Test

The contractor shall perform and support a comprehensive test program for the GLAST Observatory. The contractor's level of participation will vary depending on the nature of the specific test activity as described in this section.

4.3.4.3.1 Observatory Level Testing

The contractor shall plan, manage and execute component, subsystem, Spacecraft, and Observatory level interface verification, system testing, and environmental testing as defined in the CDRL. The contractor's integration and test program shall include as a minimum:

1. Electrical interface testing performed prior to integration of any assembly, component or subsystems into the next higher assembly. At a minimum, pin out configuration, impedance, and signal characteristics shall be verified.
2. Performance testing shall be performed immediately prior to and immediately after each element of the environmental test program. Performance testing shall verify, to the maximum extent possible, 100% functionality of all components

including the propulsion subsystem and redundant systems if applicable. Exceptions shall be coordinated and approved by the government. For the propulsion subsystem, the acceptance testing performed at the vendor shall be documented in CDRL H and shall include validation of all subsystem components (valves, transducers, lines, tanks, welds). Propulsion subsystem testing at the SC and Observatory level shall include valve open/close testing as well as leak tests both prior to and post all environments.

3. End-to-end phasing of the attitude control subsystem shall be performed after bus-level integration, and shall be repeated following any subsequent break of the flight configuration. The phasing test shall verify the polarity of all signal paths from sensors to actuators, through flight harnesses and flight software.
4. Electromagnetic Compatibility Environmental testing, appropriate for the Spacecraft offered, shall be performed to demonstrate self-compatibility of the Spacecraft and LAT and GBM instruments. Compatibility with the LV and launch site as defined by the applicable specifications for each shall also be demonstrated.
5. Thermal Vacuum Environmental testing shall be performed to demonstrate that all Spacecraft, LAT and GBM instruments function properly in their intended operational environment. RF compatibility shall be demonstrated at vacuum. RF compatibility testing in vacuum is to verify the changes of the RF Communications subsystem characteristics in vacuum and temperature environments are within specifications. RF head couplers may be installed to absorb RF radiated energy from the Spacecraft antennas inside the Thermal vacuum chamber or connected directly with hardlines to the antenna ports when antennas are not installed.
6. Environmental tests will be performed to verify Spacecraft/component performance given the expected structural loads, vibroacoustics limits, sine vibration limits, mechanical shock limits, and pressure profile induced during all phases of the GLAST mission.
7. Interface tests will be performed to verify the performance and functionality of the spacecraft internal and external interfaces, including ground and space interfaces.
8. At no time shall any test (functional or environmental) expose the payload to environments, signals, or other conditions that exceed the limits specified in the contractor's instrument ICDs.
9. The contractor shall provide science data from the LAT & GBM instruments to the LAT and GBM EGSE for the instrument developers to verify the proper operation of the instruments during system level tests. Instrument calibrations, as negotiated between the spacecraft and instrument contractors, and approved by the government, shall be supported.
10. As early as practical after the start of the system level tests, the contractor shall provide data to the operations ground system for checkout of the telemetry database in the MOC. At suitable opportunities, the contractor shall make provisions for the MOC to send commands to the observatory to check out the command database. With the help of the instrument developers and mission operations contractor, the spacecraft contractor shall plan and conduct mission

simulations to verify operations procedures and scenarios. At all times during all system level tests prior to launch, the spacecraft contractor shall be responsible for the health and safety of the observatory.

11. Flight battery usage during SC and Observatory level testing shall be minimized ensuring that flight battery life is maximized. Flight battery interfaces and operational performance within the SC and Observatory shall be validated through the use of a fit, form and functionally equivalent I&T test battery throughout observatory level testing. A CPT shall be performed post flight battery installation to validate Observatory ambient environment performance prior to launch.

4.3.4.3.2 Ground System and Operations Testing

4.3.4.3.2.1 Ground System Interface Definition

As stated in Section 4.3.4.3.1, the contractor is responsible for conducting the interface tests necessary to verify spacecraft compliance with external interface requirements. The external interfaces include NASA's Space Network, Global Positioning System, RF Ground Station(s), MOC, and launch site ground systems. The contractor shall verify Observatory outputs, format and contents, directly with the external interfaces or with simulator(s) and ground system equipment provided by the contractor. The contractor shall work closely with NASA mission engineers to perform communications, command, control, and operational requirements trade analyses. The contractor shall provide all necessary interfaces to the ground command, control and data system. This is to include all necessary system documentation, interface control documents, databases and test efforts.

The contractor shall provide an interface simulator as described in section 4.3.4.1 for the purposes of verifying the data formatting of the ground system elements.

4.3.4.3.2.2 Ground System Compatibility Tests

Ground System Compatibility Tests are performed with the coordination and participation of each mission element. Compatibility tests verify that the flight and ground aspects are capable of communicating and handling data, commands, and formats throughout the system. These tests will start as soon as possible. The contractor shall provide information necessary to define and execute these tests such as command and telemetry database, procedures and expected results from the Spacecraft perspective; the contractor shall also provide the personnel necessary to support the Spacecraft or simulator in the execution of the tests. The schedule and content of these tests will be defined later in the program, but it is expected that approximately fifteen Ground System Compatibility Tests will be required with a duration of one day each. These tests will occur during the last year and one-half prior to launch. It is preferable that the tests be supported with the Spacecraft hardware. However, the Spacecraft Simulator (as described in Section 4.3.4.1.2) or the SDMS (as described in Section 4.3.6.3) may by used for the purposes of verifying data formats and interfaces of the ground system elements. The spacecraft contractor shall lead, coordinate, and conduct all tests that involve the Observatory. The Mission Operations contractor shall lead, coordinate, and conduct all tests that do not involve the Observatory.

4.3.4.3.2.3 End-to-End System Tests

End-to-End System Tests are performed with the coordination and participation of all mission elements. These tests are designed to demonstrate the compatibility of all the elements that make up the entire mission. These tests will not commence with the Observatory until it is fully integrated with the instruments. While the ground system compatibility test may verify proper data flow and timing between two or more elements, End-to-End testing uses all elements in their desired configuration. End-to-End System

tests require observatory availability. This includes scheduling, load generation, commanding, telemetry displays, offline telemetry analysis, data ingest, and science data processing. The End-to-End tests also test the Spacecraft procedures for critical mission activities to the maximum practical extent. These tests will occur during the Observatory I&T and period will be completed 2 months before launch. The contractor shall provide information necessary to define and execute these tests and the personnel necessary to provide the spacecraft participation in these tests. The schedule and content of these tests will be determined later in the program, but it is expected that there will be approximately six End-to-End System Tests of up to 2 days each. The spacecraft contractor shall lead, coordinate, and conduct all tests that involve the Observatory. The Mission Operations contractor shall lead, coordinate, and conduct all tests that do not involve the Observatory.

4.3.4.3.3 Mission Readiness Testing

Mission Readiness Testing includes those exercises, simulations, and rehearsals used to prepare the operations staff for launch, check-out, science mission activities and contingency operations. Mission Readiness Tests will be conducted from the MOC. These tests will utilize the spacecraft wherever possible, but a sufficiently capable simulator will be used if needed. The government will use an incremental approach to mission readiness testing. These increments correspond to the complexity of the task being performed. Mission Readiness Testing will commence approximately one year before launch. Three types of readiness testing are defined. The spacecraft contractor shall lead, coordinate, and conduct all tests that involve the Observatory. The Mission Operations contractor shall lead, coordinate, and conduct all tests that do not involve the Observatory.

4.3.4.3.3.1 Exercises

This testing is performed at the subsystem level. It involves relatively few engineering and MOC operations staff. These tests are used to show that a particular command, command procedure, or command sequence produces the desired result. These tests occur on a daily or weekly time scale. These tests may last from an hourly to daily duration. The contractor shall provide timely review of all government developed command sequences and procedures. This will be a low level of effort for the contractor involving logistical support for the setup and takedown of circuits and equipment, with occasional use of the SDMS. The contractor shall answer specific questions regarding the planning, execution, and interpretation of the results of these tests.

4.3.4.3.3.2 Mission Simulations

This testing is performed at the system level and involves all space and ground elements except the launch site. The simulations involve a large number of engineering and operations staff. These simulations are based on the results of the exercises described above. Details of the simulations are mission time line dependent but will include all nominal and contingency activities. The contractor shall provide input to the simulations

plans and provide subsystem and system engineering support to accomplish the activities. It is expected that approximately twenty Mission Simulations will be required for GLAST.

4.3.4.3.3.3 Launch Rehearsals

This testing is performed with all individuals who will participate in the launch in their launch day positions. These events will require significant advanced planning, review and coordination. The contractor shall provide launch support for launch simulations and rehearsals. This effort encompasses the conduct, analyses, and evaluation of pre-launch training and simulations of the launch (through orbit insertion). There will be two rehearsals with the launch site. The contractor shall provide all personnel who will participate in the launch for these events.

4.3.4.4 Contamination Control

The contractor shall assure appropriate contamination control is maintained throughout all phases of integration and test.

The contractor shall provide an Observatory Contamination/Cleanliness Control Plan in accordance with the CDRL(s).

4.3.4.5 Spacecraft/Observatory Storage

Prior to launch, the contractor shall provide appropriate Ground Storage for the Spacecraft or Observatory at the contractor's facility. This activity shall encompass storage, storage maintenance, and post-storage activities necessary to bring the spacecraft bus to integration readiness or Observatory to launch status. This shall include, but not be limited to the storage and maintenance of spare parts as well as ground support equipment.

4.3.4.6 Spacecraft, Observatory and GSE Shipment

The contractor shall be responsible for the shipment of the Observatory, and is liable for both instruments, between the place of integration with instruments and the launch facility. The contractor shall provide for the shipment of necessary GSE required to support the Spacecraft and Observatory during each phase of test, integration, and launch preparation, including the instrument GSE. The contractor shall prepare the Observatory Transportation and Handling Plan in accordance with the CDRL(s). The government is responsible for the planning, preparation, and shipment of the instruments' GSE after launch.

The contractor shall obtain any necessary shipping permits and hazardous material exemptions, etc. During all shipments the contractor shall perform real-time monitoring of the shipping and handling environment for all controlled conditions (shock, temperature, air cleanliness, air and/or nitrogen purge, and humidity) while the

Observatory is in the shipping container.

The contractor shall reassemble, as required, and checkout all the contractor's GSE after each shipment, verifying that they are all operating within normal specification limits before their use with the Spacecraft and Observatory. The government will disassemble, reassemble and checkout the instrument GSE.

4.3.5 Launch & Operations

The government will provide the LV and the Observatory processing facility(s) and the launch site.

4.3.5.1 Launch Support

The contractor shall provide launch support of the completed Observatory. The contractor shall support launch vehicle interface definition, design verification and management, Observatory preparation and launch support, and launch readiness verification, including final checkouts, launch rehearsals and flight readiness reviews. The government will make the final go/no-go decision for launch.

4.3.5.1.1 Mission Integration Support for Launch Services

The contractor shall provide management and engineering support for all Observatory activities associated with the LV and launch services. This includes: systems integration, interface definitions, interface verification, Observatory to LV integration, ground processing facilities and GSE integration/readiness, and launch support effort. The contractor shall be responsible for assuring that compatible interfaces between hardware and software are defined, coordinating LV interface requirements definitions, and supporting and/or conducting design and safety reviews, technical interchange meetings (TIMs), and working group and ad-hoc meetings. This effort requires the development and maintenance of interfaces with all entities that play a role in Observatory launch. This involves coordinating, planning, and performing all tasks, which are necessary to implement a successful launch. The contractor shall support all activities related to the development of interface documentation and provide concurrence that the government-provided launch services contractor satisfactorily implemented all requirements.

4.3.5.1.2 Analytic and Test Support for Launch Services

The contractor shall provide management and engineering support for all analytic efforts conducted by the Government-provided launch services contractor necessary for the assessment of LV environments, interfaces, and ground processing on the Observatory design. This support includes development of detailed Observatory analytic models analysis of ground processing facility compatibility, compliance with interface safety requirements, and compatibility with LV flight environments and flight design. The government is responsible for obtaining valid coupled loads analysis results from the launch organization. The contractor shall compare the results of the coupled loads

analysis cycle to the design loads used in Spacecraft structural analyses to confirm that the resulting loads are within the design requirements as specified in the LV ICD. The contractor shall support any tests (e.g., fit checks, shock tests) and perform all tasks necessary to prepare the Observatory for launch.

4.3.5.1.3 Pre-launch Integration and Test

The contractor shall perform all tasks necessary to integrate, test, and prepare the Observatory for launch at the launch site. This includes developing Observatory/LV integration test plans, procedures, and services and performing the actual checkout of interfaces with the LV and launch facilities. This also includes the verification of all interfaces for returning data to GSFC, for example, the MILA relay link testing and voice communications through AE Comm at Cape Canaveral.

The contractor shall support LV testing and launch simulations and rehearsals as necessary.

4.3.5.1.4 Launch Operations

The contractor shall provide all required integration, safety, and engineering support to process the Observatory through the ground processing facilities, launch facility, and the LV. In addition, this effort shall encompass the contractor's efforts necessary to support the actual launch, post-launch orbit insertion, perform Observatory initialization, deployments, and preparation for on-orbit performance verification testing. This activity will be under government direction from launch through separation of the Observatory from the LV.

4.3.5.2 Flight Operations Interfaces and Support

The government will provide the ground systems and flight operations team for Observatory operations. The government furnished Mission Operations Center (MOC) operations team shall be responsible for the on-orbit operations of the Observatory. The contractor shall train the MOC operation team and their own operations team, including System Lead and subsystems engineering support referenced in section 4.3.5.4, for on-orbit initialization, checkout, performance verification, and anomaly resolution. The contractor shall videotape and provide spacecraft subsystem training presentations to the government for future training usage. The contractor shall perform training mission simulations for rehearsal of on-orbit mission phases including nominal operations simulation and simulations with contingencies as part of the simulations described in 4.3.4.3.3.

The contractor shall provide support to the MOC in verifying interfaces and operational data flows. This support shall include assistance in planning, developing, executing, and assessing interface verification tests as described in section 4.3.4.3.2.

The contractor shall provide a flight software user's manual and spacecraft bus operations

manual, with sufficient detail to be used by the flight operations team for flight operations, as described in the CDRL(s).

4.3.5.3 On-Orbit Performance Verification

The contractor shall perform an on-orbit performance verification program that shall confirm that the Observatory performance is in accordance with the mission requirements, specifications, and interfaces. The GLAST Instrument Operations Team(s) will perform the necessary Instrument testing. As a minimum the contractor shall perform:

1. Observatory On-Orbit Check-Out - After the Observatory has reached the operational orbit and deployed/released all appendages/mechanisms, the contractor shall perform a check-out to verify the post-launch performance and state-of-health of the Observatory. All systems shall be verified for proper function and performance. The check-out shall be planned to occur prior to 60 days on-orbit, but may occur later if Spacecraft anomalies are not resolved. The contractor shall provide their on-orbit check-out plan to the government in accordance with the mission performance verification plan. The contractor shall prepare a report that summarizes the on-orbit performance of the Observatory compared to its required performance for the mission after launch. All pertinent issues affecting mission success shall be addressed. The extent of performance explanation required depends on the seriousness of the impacts that any problems identified may have on mission success. The contractor shall also provide an assessment of the flight operations team's readiness to assume operational control of the Observatory. This report summarizes the Observatory performance on-orbit after launch and check-out to determine initial mission success. Government acceptance of the Observatory will occur after the on-orbit check-out successfully demonstrates that all applicable contract performance requirements have been met. The responsibility for the Observatory remains with the contractor until the government signs the Material Inspection and Receiving Report (DD250).

2. Observatory to Ground Control and Data Systems Interface Verification - This effort shall be performed by the contractor after the Observatory on-orbit performance and state-of-health have been confirmed. The purpose of this test is to verify proper operations of the Observatory to ground system interfaces and to provide the necessary calibrations.

3. 60-Day On-Orbit Performance Report – The contractor shall prepare a report which summarizes the on-orbit performance of the Spacecraft compared to its predicted performance for the mission after launch. The contractor shall address each subsystem and the performance of launch and include flight operations crews. All pertinent issues affecting mission success shall be addressed. The extent of performance explanation required depends on the seriousness of the impacts that any problems identified may have on mission

success. This report summarizes the spacecraft bus performance on-orbit after launch and check-out to determine initial mission success and completion payment milestone status.

4.3.5.4 Support to On-Orbit Operations

The contractor shall support 60 days of Observatory check-out and operations following launch and Observatory separation. The contractor shall provide System lead and subsystem engineering support at the MOC on an around-the-clock basis until all Spacecraft subsystems are completely activated and the Observatory is in the mission orbit, 12 hr. x 7 day coverage through instrument activation, and 8 hr. x 5 day until Observatory acceptance by the government. The government will provide Instrument check-out and operations support during this time.

4.3.5.4.1 Anomaly Resolution and Spacecraft Acceptance

The contractor shall resolve all out-of-specification on-orbit performance issues as assigned to the contractor by the GLAST Project Office. This support shall remain effective until the end of the 60 day check-out period, or until Observatory acceptance by the government, whichever occurs later. (The contractor shall provide any post-60 day support required to resolve such pre-acceptance Spacecraft anomalies.) This includes support of periodic conference calls on the status of anomalies under investigation.

For out-of-family, but in-specification and non-specified performance, the contractor shall perform on-orbit task assignments as authorized by the Government in accordance with contract clause I.A.1- RATES FOR NON-STANDARD SERVICES, per Attachment M. Each task will be initiated by written direction from the CO, and shall be coordinated with the contractor to define the details of the task, its manpower ceiling, and scheduling requirements.

4.3.5.4.2 Observatory Database Support

The contractor shall correct all discrepancies discovered in the databases until the end of the Observatory acceptance period.

4.3.5.4.3 On-Orbit Trending

The contractor shall develop and implement an on-orbit Observatory engineering trending program and operate it until the end of the Observatory acceptance period when the contractor shall handover the responsibility to the Mission Operations contractor. The program shall identify parameters to trend, and then monitor all parameters on a routine basis, analyzing the data with the intent to identify anomalous performance, out-of-family performance, degradation of components, characterize nominal aging effects, and predict EOL, etc. Comparisons shall be made between on-orbit performance and Observatory-level pre-launch test data. The contractor shall make this data available to the Government for review during the Observatory acceptance period.

4.3.6 Flight Software

The contractor's approach and plans for development and modification of the flight software shall be documented in a Software Management Plan in accordance with the CDRL.

The contractor shall treat the software component of firmware, which consists of computer programs and data loaded into a class of memory that cannot be dynamically modified by the computer during processing (e.g., programmable read-only memories) as software for the purposes of this SOW. For devices such as programmable logic arrays and application specific integrated circuits (ASICs) with new designs, the contractor shall conduct a suitable review program.

Auto-generated software and its sources, e.g. - databases, models or other sources, shall also be considered software for the purposes of this SOW.

4.3.6.1 Software Management Requirements, Development, Verification, and Testing

The contractor shall perform industry accepted software management approaches to: software analysis, design, development, documentation, version control, test, verification, and assurance of all software products. This systematic approach shall be detailed in the Software Management Plan (SMP) as described in the CDRL.

The contractor shall perform all analyses and software systems engineering required to allocate (from system and subsystem requirements) and identify software requirements, and to develop necessary Flight Software Requirements Specifications (SRS) for the Observatory, as described in the CDRL. Software requirements traceability to system and subsystem requirements shall be provided in traceability matrices.

The contractor's Flight Software design shall be captured and maintained in the FSW Software Design Document (SDD), as described in the CDRL.

The contractor's Flight Software testing approach, methodology, procedures and results shall be documented in the Flight Software Test Package (STP), as described in the CDRL. The first section, Test Plan will describe all phases of the software testing, from informal routine and function tests through the FSW Acceptance Tests shall be carried out conforming to this documented plan. The second section will contain the detailed testing procedures, which shall be captured and maintained. The last section, Flight Software Acceptance Tests shall be documented here with Flight Software Test Reports.

With each delivery of verified and tested software, the contractor shall concurrently deliver a Flight Software Version Description Document (VDD), as described in the CDRL, which describes in detail the contents of that particular version of the Flight

Software. It includes functionality of the build, the requirements satisfied, as well as any deficiencies known to exist in the specified version.

The Software User and Maintenance Manual, as described in the CDRL, shall contain the information required to use and maintain the flight software, including detailed procedures for building, linking, troubleshooting and 'patching' the flight software. It shall include any instruction checklists, diagrams, illustrations, etc. which would facilitate the maintenance of the code.

The contractor shall hold reviews for Flight Software, as described in the CDRL, which may be scheduled adjacent to mission or other reviews, but where software is discussed separately. These reviews shall provide a greater understanding and in-depth look at the flight software and all associated processes and risk evaluation.

Requirements, design, and code walkthroughs or inspections shall be conducted at the contractor's facility at the appropriate software developmental life-cycle phase, in accordance with this DO, to ensure the correctness of the requirements, design, and source code. These walkthroughs/ inspections shall be open to Government participation. The coding, debugging, and developer testing efforts, the results of the walk-throughs, and programmer's notes shall be documented and available for Government review.

The contractor shall provide all the resources necessary to verify and validate all the software developed for the Observatory.

4.3.6.2 Software Maintenance

The contractor shall maintain the flight software and documentation to ensure reliability, maintainability and operability, along with the environments, emulators, and test software necessary to develop and verify these systems until on-orbit acceptance of the Observatory. The contractor shall provide all necessary products and training to allow the government to maintain the flight software after on-orbit acceptance.

The contractor shall retain all Flight Software and other software product's documentation for the complete software life cycle development until the end of the baseline mission life. This documentation will be used for maintenance of the system and shall be accessible to the government until the end of the baseline mission life.

4.3.6.3.1 Software Development and Maintenance System

The contractor shall provide all the necessary ground based hardware, software, development tools, procedures, and documentation to the government to maintain the Flight Software after on-orbit acceptance. This hardware, software, development tools, procedures and documentation shall be referred to as the Software Development and Maintenance System (SDMS). The SDMS shall consist of necessary engineering units and associated ground support equipment, all the hardware platform(s), and software tools used in development of the Flight Software, including all simulators, emulators,

compilers, code generation systems, debuggers, linkers, test software and all procedures and scripts used for testing. This includes a complete test environment to validate any flight software modifications. The SDMS shall contain all tools and utilities required for formatting executable code for uplink to the spacecraft. The fidelity of the SDMS shall be sufficient to validate flight software modifications,

The contractor shall provide a Ground Reference Image of the executable code in PROM and EEPROM on the spacecraft as well as the Flight Software in use on board at acceptance, should they be different (i.e. – Any patches or operational uploads required to get to the acceptance baseline).

4.3.7 Miscellaneous Activities

4.3.7.1 Deleted

4.3.7.2 Deleted CH-03

4.3.7.3 Deleted

4.3.7.4 Deleted

4.3.7.5 Deleted

4.3.7.6 Deleted CH-03

4.3.7.7 Deleted

4.3.7.8 Deleted

4.3.7.9 Solid State Recorder CH-02

The contractor shall develop a system that includes a 160 Gbit (base 2) solid state recorder. CH-05

4.3.7.10 Ku-band Downlink

The contractor shall remove the spacecraft X-band downlink system and replace it with a TDRS compatible Ku-band downlink system at 40 megabits per second (Mbps). The Ku-band return system shall support the downlink of stored science, stored housekeeping, alerts, diagnostic data, and real-time housekeeping data. The contractor shall perform all procurement activities, systems engineering, safety and mission assurance, manufacture, assembly, testing, launch, on-orbit checkout, and post-launch support necessary to implement, incorporate, and operate the Ku-band downlink system within the GLAST Observatory as specified in this delivery order. CH-03

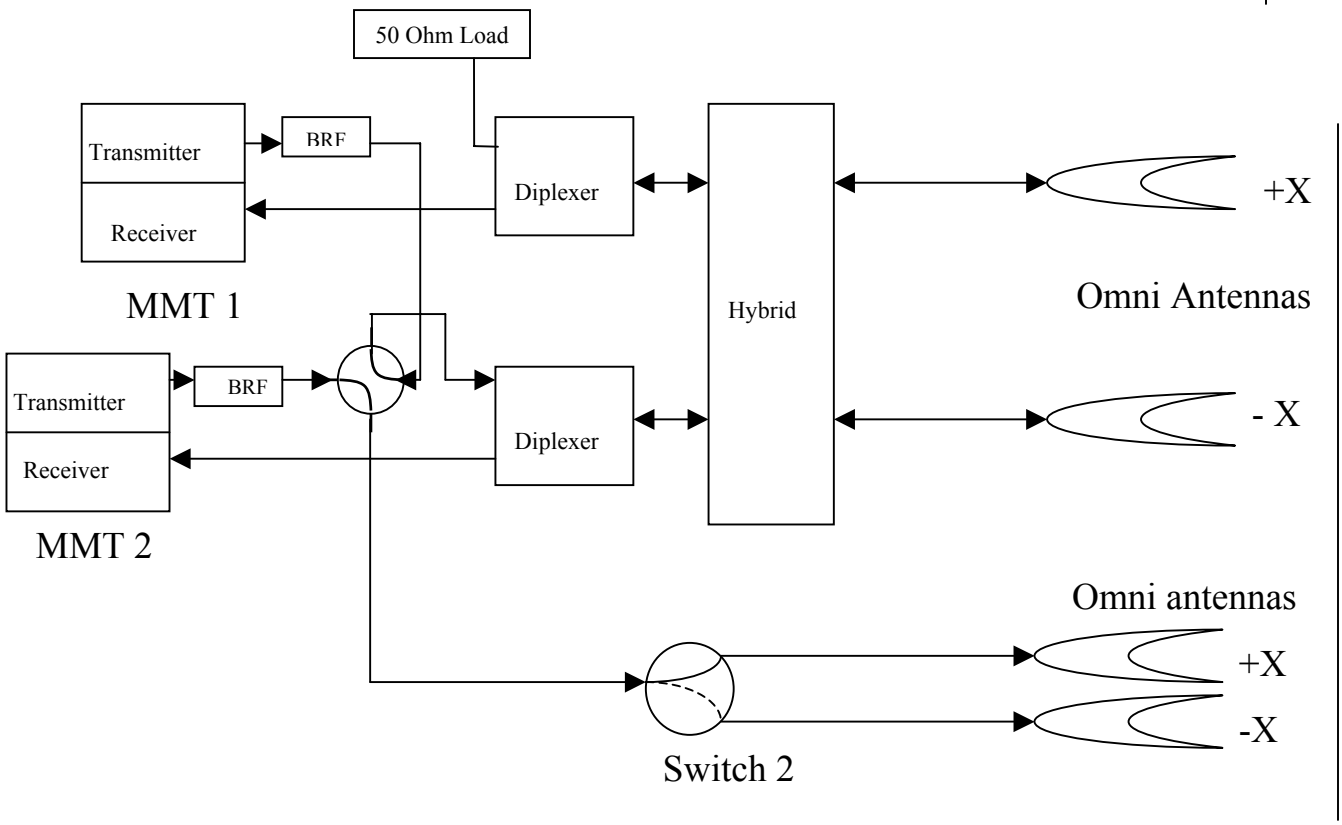
4.3.7.11 Deletion of the Independent Safe Mode (ISM)

The contractor shall remove the software based Independent Safe Mode (proposed Option –B on 433-SOW-0002) from the baseline spacecraft architecture. This includes removal of the relevant software requirements, design and testing from the baseline program. CH-07

4.3.17.12 S-band Downlink

The contractor shall modify the baseline S-band antenna network design to conform to the implementation shown in the block diagram below. The contractor shall perform all procurement activities, systems engineering, safety and mission assurance, manufacture, assembly, testing, launch, on-orbit checkout, and post-launch support necessary to implement, incorporate, and operate the S-band antenna network within the GLAST Observatory as specified in this delivery order.

Compliance with the S-Band Coverage and Data Rates requirement will be verified by the Government using an analysis performed by NASA GSFC Code 450. Spectrum shall provide antenna pattern data of the flight hardware to GSFC for verification of compliance. This analysis will use the configuration identified in figure below, and all details of the analysis will be provided to Spectrum for concurrence of model validity. CH-09



CH-09

4.4 DO Options

Option-1 90-day Instrument delivery delay with concurrent 90-day Launch delay option (may invoke up to 6 times)

The contractor shall price an option to accommodate a 90 calendar day slip in the delivery schedule for any or all Instruments as indicated in the GFE List, Attachment K, with a concurrent 90 calendar day launch delay. The latest notice for the first invocation of this option is 60 calendar days prior to the baseline delivery date. For the next 5 invocations, the latest notice is 60 calendar days prior to the most recently established delivery date.

Option-2 12 months of flight software maintenance including documentation (may invoke up to 5 times)

The contractor shall price an option to maintain the flight software and documentation to ensure reliability, maintainability and operability, along with the environments, emulators, the SDMS, and test software necessary to develop and verify these systems. This option will be invoked with at least 90 calendar days' notice prior to launch or each subsequent option period.

Option-3 Current conditioning for GBM Instrument

The LAT Instrument requires a 28 +/- 1 VDC power bus. The contractor shall price an option to provide the GBM instrument with a 28 +/- 1 VDC power bus and current limiting capabilities that meet the following requirements:

A. GBM Current Transients

The following requirements shall be measured when supplied by a voltage source having the impedance characteristics of the spacecraft power source impedance:

1. Current peaks associated with both turn-on inrush current and non-repetitive operational current transients shall not exceed 200% (TBR) of the GBM peak power current between 50 microseconds (usec) and 10 milliseconds (msec) after the start of the transient and shall return to steady-state within 10 msec from the time of the peak of the transient.

2. During normal operations the GBM current transient rate of change shall be limited to ≤ 20 milliamps (mA)/usec (TBR).

3. The GBM turn-on inrush current transient rate of change shall be limited to ≤ 50 mA/usec (TBR).

4. The GBM turn-off current transient rate of change shall be limited to ≤ 50 mA/usec (TBR).

B. Power Source Impedance

The PSE output impedance shall be less than (TBD) ohms to 1 MHz (TBR).

This option will be invoked with at least 30 calendar days notice prior to the SRR.

The input circuit to the GBM power unit is as depicted in Figure 1.

Primary Power Interface (PDU-GBM-PB)

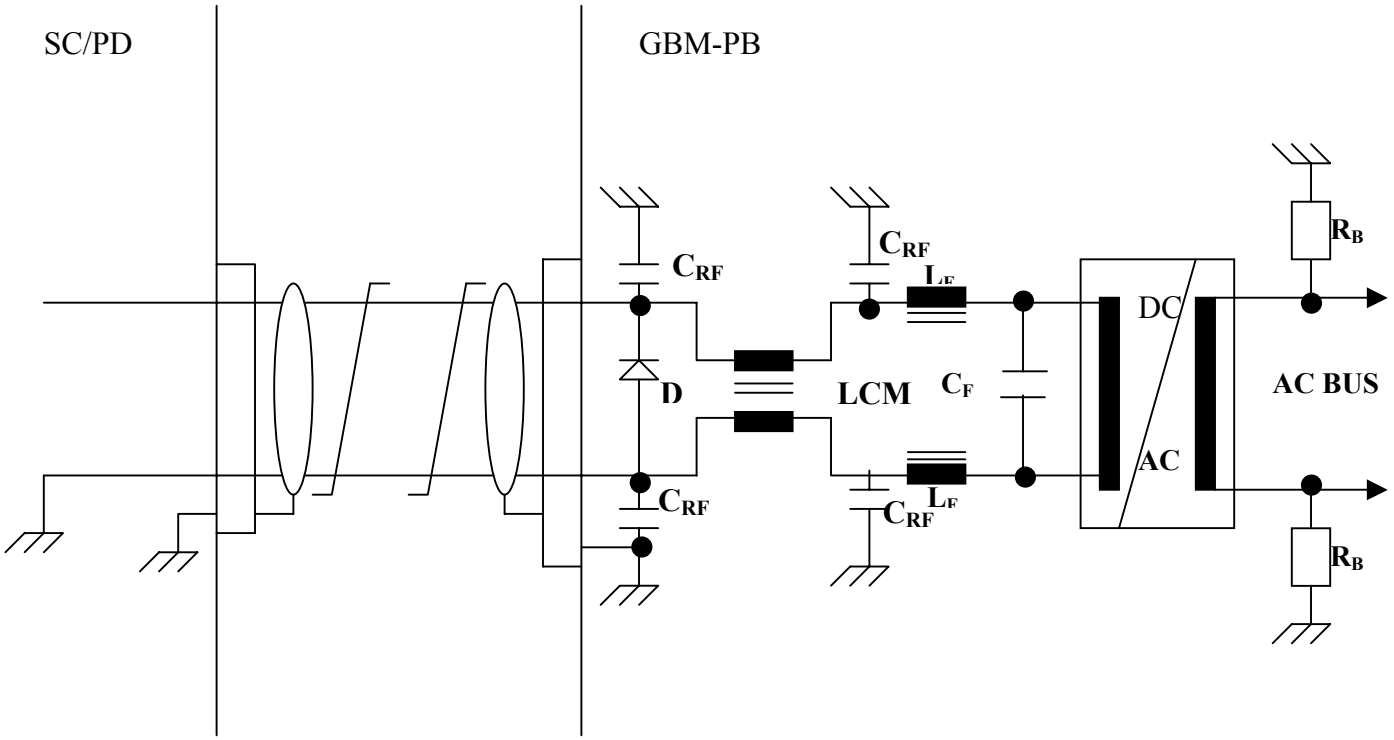


Figure 1: Primary Power Interface

Values are:
C_{RF} =RF Filter Capacitor (two 22nF capacitors in series)
R_B =Balancing Resistor (two 100K resistors in series)
D1 =Inverse Polarity Protection Diode (two diodes TBD in series)
L_{CM} =Common Mode Choke
L_F =Filter Choke
C_F =Filter Capacitors

Option-4 12 months of MOC Training Simulator maintenance including documentation (may invoke up to 5 times)

The contractor shall price an option to maintain the MOC Training Simulator and documentation to ensure reliability, maintainability and operability, along with the environments, emulators, and test software necessary to develop and verify these systems**.**

This option will be invoked with at least 90 calendar days notice prior to launch.

Option-5 Controlled Re-entry: Increased Reliability for Controlled Reentry

The offeror shall price an option to increase the reliability for systems necessary to implement a controlled reentry. The offeror shall examine methods to increase the reliability of controlled reentry after five years and ten years in orbit, under the assumption that only the spacecraft functions necessary to support reentry are necessary at those times. The offeror shall consider and include all costs attributable to the controlled reentry requirement including system engineering and analysis, design, simulation, components procurement, integration and test, on-orbit tests, changes to the ground system, planning and conducting the reentry operation, and any other applicable cost element. The additional costs for increased reliability shall be provided in a few discrete steps corresponding to the proposed design changes. Note: There is no requirement for a specific reliability number to be met.

This option will be invoked with at least 30 calendar days' notice prior to SRR.

Option-6 Battery Life Test

The offeror shall price an option to commence life testing of 10 cells in 2, five-cell packs procured from the same lot as the flight cells. The test shall start at least two years before the scheduled launch date, and continue for at least twelve years or until the Observatory de-orbits. The offeror shall prepare a test plan to duplicate as nearly as practicable the thermal and electrical conditions that the flight batteries are expected to experience on orbit. The offeror shall deliver the battery test plan and the test cell-packs to GSFC, where the life test will take place.

This option will be invoked with at least 30 calendar days' notice prior to MCDR.

A preliminary version of this CDRL is due with the proposal quote for this option. The final version is due only if this option is exercised.

Title: Battery Test Plan	**CDRL No.: Option-**6
Reference: GLAST Project Spacecraft Performance Specification 433-SPEC-0003 Section 171	
Purpose: To define a battery test plan that mimics in the probable in-flight operation of the battery.	
Related Documents: To Be Supplied (TBS)	
Preparation Information The contractor shall prepare a test plan to duplicate as nearly as practicable the thermal and electrical conditions that the flight batteries are expected to experience on orbit. The contractor shall include the following information: battery temperature, and battery charge and discharge profiles for a variety of beta angles and selected orbits during the spacecraft's anticipated life. The contractor shall deliver the battery test plan and the test cell-packs to GSFC, where the life test will take place. The contractor shall include the following information: battery temperature, and battery charge and discharge profiles for a variety of beta angles and selected orbits during the spacecraft's anticipated life.	

Option-7 Delete Autonomous Repointing

The offeror shall price an option to delete the implementation of autonomous repointing. Deletion of this option shall not impact meeting the other operational constraints.

This option will be invoked with at least 30 calendar days after SRR.

Option- 8 Delete MOC Training Simulator

The offeror shall price an option to delete the delivery of the MOC training simulator to the government from the baseline. This option will be only be exercised if Option 13 is exercised. Note: If the government exercises Option 13, although a MOC training simulator is still required, it would not be a deliverable.

Option-9A Independent Safe Mode Processor

The offeror shall price an option that employs a dedicated, safe mode GNC processor, separate from the normal mode processor. To ensure software independence, the safe mode processor shall be of a different type and have a different operating system than is used by the normal mode processor. All safe mode software, including math library functions, shares no code with normal mode software. This option will be invoked with at least 30 calendar days' notice prior to SRR.

Option-9B Software Augmentation for Safe Mode Independence

The offeror shall price an option to implement complete software independence of the Safe Mode. For this option, all safe mode software in the baseline system, including math library functions, shares no code with normal mode software. This option will be invoked with at least 30 calendar days' notice prior to SRR.

Option-10A 15 MHz X-band Downlink Bandwidth

Space science missions are normally allocated 10 MHz of bandwidth in the 8.450 to 8.500 GHz range of X-band for space to ground links. The baseline GLAST specifications call for a data rate on the X-band downlink compliant with a 10 MHz null-to-null bandwidth of the main lobe (bandwidth definition as used by the GSFC Spectrum Allocation Office). It is beneficial to GLAST science and ground operations to have the use of bandwidth greater than 10 MHz to support a higher data rate. The GLAST Project intends to pursue a waiver for a higher bandwidth allocation from spectrum management authorities. It is anticipated that the schedule for acquiring a waiver will be driven by regulatory administrative procedures.

The offeror shall price an option for a 15MHz, X-band downlink communications systems. 15 MHz bandwidth refers to the null-to-null bandwidth of the main lobe of the signal (bandwidth definition as used by the GSFC Spectrum Allocation Office). This option shall include a schedule relative to the program schedule describing what decisions must be made at what time in order to exercise the option.

The offeror shall demonstrate how their communication system design complies with the spectrum allocation constraints relevant to this option.

This option will be invoked with at least 60 days prior to MCDR.

Option-10B 20 MHz X-band Downlink Bandwidth

The offeror shall price an option for a 20 MHz, X-band downlink communications systems. 20 MHz bandwidth refers to the null-to-null bandwidth of the main lobe of the

signal (bandwidth definition as used by the GSFC Spectrum Allocation Office). This option shall include a schedule relative to the program schedule describing what decisions must be made at what time in order to exercise the option.

The offeror shall demonstrate how their communication system design complies with the spectrum allocation constraints relevant to this option.

This option will be invoked with at least 60 days prior to MCDR.

Option-11 Intentionally left blank

Option-12 Extended Mission Lifetime: Mission Operations for 5 years

The offeror shall price an option to provide mission operations, from the Mission Operations Center described in Option 13, for up to an additional 5 years. In the event that Mission Operations services are not required for 5 years, the government has a right to negotiate an equitable adjustment. This option will be invoked with at least 6 months notice prior to the end of the previous 5 year period.

Option-13 Mission Operations Center Development and Mission Operations for up to 5 years

An option shall be priced for the contractor to provide a non-GFE, Mission Operations Center and perform the mission from this facility. Under this option, the contractor shall provide all personnel, services, materials, facilities, software and hardware required to develop, deliver, install, verify, operate and maintain the GLAST Mission Operations Center for up to 5 years. In the event that Mission Operations services are not required for 5 years, the government has a right to negotiate an equitable adjustment. This option will be invoked within ARO plus 8 months notice.

The Mission Operations Center is the primary link between the ground-receive sites and the science community as described in the Mission Operations Concept Document 433-OPS-0001. This option has two major components 1) Mission Operations Center Development and 2) Mission Operations.

13.1 Mission Operations Center Development
As the Mission Operation Center Developer, specific responsibilities of the contractor include:

13.1.1 Reviews
13.1.1.1 MOC Ground System - System Concept Review

The contractor shall provide a System Concept Review of the MOC Ground System design concept to verify that all major performance requirements and interfaces are understood. Major hardware and software alternatives and supporting trade studies shall be presented for discussion. Performance and schedule risk areas shall be discussed. See CDRL O13-1 for data package requirements.

13.1.1.2 MOC Ground System - Preliminary Design Review

The contractor shall provide a Preliminary Design Review of the MOC Ground System design, detailing the purpose and function of each Ground System element within the MOC. The PDR shall also present the Ground System Test Plan. See CDRL O13-2 for data package requirements.

13.1.1.3 MOC Ground System - Critical Design Review

The contractor shall provide a Critical Design Review of the MOC Ground System final detailed design, including all software and hardware elements. All comments and concerns raised, and all changes made since PDR will be addressed. Final calculations of system performance shall be presented. See CDRL O13-3 for data package requirements.

13.1.2 Documentation

The contractor shall provide the following Ground System Documentation:

13.1.2.1 Ground System Operations Manual

The Ground System Operations Manual described all functions that can be accomplished with the MOC using the Ground System. Constraints on operations and contingency operations are included. See CDRL O13-6 for data requirements.

13.1.2.2 Ground System Test Plan

The Ground System Test Plan describes the means by which the contractor shall demonstrate the Ground System meet its requirements. See CDRL O13-7 for data requirements.

13.1.2.3 Ground System Procedures

The actual procedures use by the Ground System to accomplish the mission. These procedures are the implementation used to accomplish the functions set out in the Ground System Operations Manual. See CDRL O13-8 for data requirements.

13.1.2.4 Integrated Mission Schedule input

Monthly input to the Integrated Mission Schedule consists of updated status of all ongoing Ground System activities.

13.1.3 Work to Be Performed

13.1.3.1 Design

13.1.3.1.1 Design a MOC in accordance with the Mission Operations Concept Document. The design shall include requirements analyses,

appropriate software and hardware solutions to meet the requirements, and estimates of time and cost to implement and test the proposed system.

13.1.3.2 Implementation

13.1.3.2.1 Determine the location of the MOC that presents the government with the most favorable cost and risk. This determination should be derived from the interface requirements of the MOC based on other elements as defined in the Operations Concept Document.

13.1.3.2.2 Procure all hardware required for the MOC.

13.1.3.2.3 Determine software requirements for the MOC.

13.1.3.3 Ground System Internal Testing

Internal Testing of the MOC Ground system shall include:

13.1.3.3.1 Network elements

13.1.3.3.2 Real time System

13.1.3.3.3 Planning and Scheduling System

13.1.3.3.4 Archival System

13.1.3.3.5 Analysis and Trending System

13.1.3.3.6 FSW Memory Management System

13.1.3.3.7 Voice Communications System

13.1.3.3.8 Level Zero Processing

13.1.3.4 Ground System Compatibility and End to End System Testing

Provide the lead role in the performance of Ground System Compatibility Tests and End to End Systems tests using all ground system elements. To accomplish any given test, the contractor shall perform the following activities:

13.1.3.4.1 Devise the test goals and requirements.

13.1.3.4.2 Schedule the test and coordinate resources.

13.1.3.4.3 Conduct all subsystem reviews of the commands, telemetry monitors, procedures, scripts, contingency plans, etc., to be used during the test.

13.1.3.4.4 Conduct a final script review approximately one week prior to each test to cover the test plan, procedures, scripts, and test support and coordination activities.

13.1.3.4.5 Execute the planned command procedures and generate supporting data products during the test.

13.1.3.4.6 Obtain and process all supporting data into a post-test report.

13.1.3.4.7 Resolve anomalies and incorporate lessons learned for future tests.

13.1.3.5 Flight Operations Exercises, Simulations & Rehearsals

Provide the lead role in the performance of the exercise, simulations and rehearsals required for a successful launch and mission. To accomplish these activities the contractor shall:

13.1.3.5.1 Devise the goals and resource requirements
13.1.3.5.2 Schedule the activity based on resource constraints
13.1.3.5.3 Conduct reviews of planned activity with participants
13.1.3.5.4 Execute the activity and collect appropriate data
13.1.3.5.5 Create post activity report to document results.
13.1.3.5.6 Resolve anomalies and incorporate lessons learned into future activities.

13.2 Mission Operations

The Mission Operations portion of this option shall provide the price of performing all routine, pre-planned, and nominal activities required to successfully execute the GLAST mission. The pricing shall include per year cost of operating the MOC for years 1 through 10. Specific activities shall include:

13.2.1 Reviews

13.2.1.1 Pre-Launch

13.2.1.1.1 Mission Operations Review

The contractor shall support a Mission Operations Review by providing/presenting inputs concerning the MOC Ground System. See CDRL O13-4 for data package requirements.

13.2.1.1.2 Flight Operations Review

The contractor shall support a Flight Operations Review by providing/presenting inputs concerning the MOC Ground System. See CDRL O13-5 for data package requirements.

13.2.1.1.3 Monthly Status Reviews

The contractor shall provide Ground System inputs to the Monthly Status Review data package.

13.2.1.2 Post Check-out

13.2.1.2.1 Weekly Observatory Reports

The contractor shall provide a generalized report which includes weekly status of each subsystem in the observatory and ground system. Anomalies of the previous week are described.

13.2.1.2.2 Monthly Observatory Reports.

The contractor shall provide adetailed, monthly subsystem by subsystem report addressing the continuing performance of the observatory. The contractor shall include a description of all open anomalies and a historical record of all anomalies shall be attached.

13.2.2 Documentation

The contractor shall provide the following Mission Operations documentation:

13.2.2.1 Facilities Plan

The Facilities Plan shall describe the design, layout, implementation, and testing of the physical space of the MOC. See CDRL O13-9 for data requirements.

13.2.2.2 Operations Procedures

The contractor shall provide Operations Procedures which include the configured set of procedures used to accomplish all activities with the MOC including both spacecraft and ground procedures for nominal and contingency operations. See CDRL –O13-10 for data requirements.

13.2.2.3 Security Plans

The contractor shall provide Security Plans which include all documentation required to assure compliance with NPG 2810.1, the Risk Assessment Plan, Risk Management Plan, and the IT Security Plan.

13.2.2.4 Staffing Profile

This document shall show the time evolution of staffing requirements from pre-launch to de-orbit.

13.2.3 Work to be performed

Operating the GLAST shall include all of the following:

13.2.3.1 Scheduling upcoming Ground Station and TDRS support
13.2.3.2 Commanding the observatory.
13.2.3.3 Monitoring the real time housekeeping telemetry data.
13.2.3.4 Receiving playbacks of high rate telemetry data from the Ground Station or TDRS
13.2.3.5 Sending level 0 processed science data to the SSC, the LAT IOC and the GBM IOC.
13.2.3.6 Performing off line analysis on the housekeeping data to determine trends in the observatory's performance.
13.2.3.7 Up-linking weekly stored command loads
13.2.3.8 Managing changes to observatory flight software.
13.2.3.9 Managing changes to the observatory databases.
13.2.3.10 Managing burst alerts.
13.2.3.11 Target of Opportunity
13.2.3.12 Archiving housekeeping data
13.2.3.13 In case of any observatory anomaly or emergency, the staff shall ensure that the spacecraft is brought back to operational functionality.

Title: Mission Operations Center Ground System – System Concept Review Data Package	**CDRL No.:** Option 13-1
Reference: Mission Operations Concept Document Mission Systems Specification	
Purpose: The SCR is held to assure that the objectives and requirements of the ground system being designed are understood and that the proposed approach will meet these requirements. The emphasis should be on the requirements, how they flow down, the proposed design concept and the definition of the major system interfaces. Detailed interfaces are part of later reviews. The output of the SCR is a baseline design subject to the closure of any action items resulting from the review.	
Related Documents:	
Preparation Information The SCR data package shall contain the following minimum material: 1. Mission Objectives 2. Mission Operations Concept 3. Instrument Requirements 4. Constraints 5. Technical and Performance Requirements 6. Organizational Interfaces 7. Technical Interfaces 8. System Drivers 9. Security Considerations 10. Risk Areas 11. Proposed Design Approach 11.1 System Design 11.2 Networks 11.3 Facilities 11.4 Hardware 11.5 Software 12. Specialized Ground Support Equipment 13. Test Program 14. Operations and Maintenance	
Special Preparation Instructions This CDRL is only required in accordance with Option 13 and is not part of the baseline contract.	

Title: Mission Operations Center Ground System – Preliminary Design Review Data Package	**CDRL No.:** Option 13-2

Reference:
Mission Operations Concept Document
Mission Systems Specification

Purpose:

The PDR is the first major review of the detailed design and is only held after the design is sufficiently advanced to allow discussion of such details. Complete detailed designs are not expected, but system engineering, resource allocations, and design analyses are required to demonstrate compliance to the requirements. A presentation of the design and interfaces by means of block diagrams, signal flow diagrams, schematics, logic diagrams, link margin analyses, configuration layouts, and any early results are required. Supporting data and analyses should be provided. Software requirements, design, structure, logic flow diagrams, processor loading, design language and developments systems need to be specified. Robustness of the design needs to be shown.

The PDR review process is intended to serve as an interim step in the design process where the government and the contractor agree that the design is proceeding as planned.

Related Documents:

Preparation Information

The PDR data package shall contain the following minimum material:

1. Instrument and Communications Objectives
2. Mission Operations Concept
3. Closure of Actions from prior reviews
4. Performance Requirements
5. Data Rates and Data Processing Requirements
6. Telemetry and Command Processing Requirements
7. Interface Requirements
8. Software Requirements and Design
9. Specialized Ground Equipment Interfaces
10. Mission and Flight Operations
11. Requirements Trace-ability Matrix

Special Preparation Instructions

This CDRL is only required in accordance with Option 13 and is not part of the baseline contract.

Title: Mission Operations Center Ground System – Critical Design Review Data Package	**CDRL No.:** Option 13-3

Reference:
Mission Operations Concept Document
Mission Systems Specification

Purpose:

The CDR is held near the end of the design stage of development. The CDR presents a final, detailed design, using substantially completed drawings, to show the design will meet the final performance and interface specifications and the required design objectives. The CDR should represent a complete and comprehensive presentation of the entire design. It should include all changes to the design presented at the PDR. Final software requirements and updated system performance estimates should also be presented. Calculated System Reliability and results of FMEA and FTA analyses are to be presented. The CDR should include all the items from the PDR in addition to those listed below.

Completion of the CDR and resolution of all action items generated by it constitutes the baseline design of the Ground System. Formal Configuration Control shall begin no later than the date of the CDR.

Related Documents:

Preparation Information

The CDR data package shall contain the following minimum material:

1. Instrument and Communications Objectives
2. Closure of Actions from prior reviews
3. Performance Requirements
4. Data Rates and Data Processing Requirements
5. Telemetry and Command Processing Requirements
6. Interface Requirements
7. Software Requirements and Design
8. Specialized Ground Equipment Interfaces
9. Mission and Flight Operations
10. Requirements Trace-ability Matrix

Special Preparation Instructions

This CDRL is only required in accordance with Option 13 and is not part of the baseline contract.

Title: Mission Operations Center Ground System – Mission Operations Review Data Package	**CDRL No.:** Option 13-4

Reference:
Mission Operations Concept Document
Mission Systems Specification

Purpose:

The MOR is the first of two reviews held which concentrate on the ground system and flight preparations. All mission-oriented operations will be addressed. The overall design and status of the ground system is reviewed to assured observatory data, operations, and analysis requirements will be met by the proposed approach. The operational interfaces will be reviewed with respect to proper system engineering of operational trade-offs, signal link margins, constraints and modes including safe modes. Mission integration of pre-launch planning including all planned tests between the flight and ground system will be addressed. The relationship between planned ground system software releases/capabilities and planned tests with the flight segment will be included. The plans and status of the flight operations and science operations preparations will be presented.

The MOR should occur prior to significant integration and test of the flight and ground systems.

Related Documents:

Preparation Information
The MOR data package shall contain the following minimum material:

1. Instrument and Communications Objectives
2. Overall Schedule and Status.
3. Closure of Actions from prior reviews
4. Performance Requirements
5. Mission, Instrument, Communications, Flight Software, and Ground System Overviews
6. Flight Software Maintenance
7. Flight Operations Team build up and Training Plans
8. Pre-launch Test Plans
    - 8.1 RF Compatibility Tests
    - 8.2 Ground System Compatibility Tests
    - 8.3 End-to-End System Tests
    - 8.4 Exercises, Simulations, and Rehearsals
9. Launch and Early Orbit Activities
10. Check-out Overview
11. Database and Procedure Development
12. Mission and Flight Operations Constraints
13. Mission Planning and Scheduling
14. Contingency Operations
15. Trending Requirements
16. Science Operations Planning, Processing and Analysis
17. Issues and Concerns

Special Preparation Instructions
This CDRL is only required in accordance with Option 13 and is not part of the baseline contract.

Title: Mission Operations Center Ground System – Flight Operations Review Data Package	**CDRL No.:** Option 13-5
Reference: Mission Operations Concept Document Mission Systems Specification	
Purpose: The FOR is held near the completion of pre-launch testing between the observatory and ground system. The plans for final end-to-end system testing will be reviewed. The results of previous tests will be included. The final launch, checkout and orbital operations plans will be presented.	
Related Documents:	
Preparation Information The FOR data package shall contain the following minimum material: 1. Closure of Actions from the MOR 2. New requirements and changes to plans. 3. Test result summaries including criticality assessment of open problems 4. Work remaining 5. Personnel deployment for launch and check-out 6. Contingency procedure development and validation status.	
Special Preparation Instructions This CDRL is only required in accordance with Option 13 and is not part of the baseline contract.	

Title: MOC Ground System Operations Manual	**CDRL No.:** Option 13-6
Reference: Mission Operations Concept Document Mission Systems Specification	
Purpose: The MOC Ground System Operations Manual describes how to perform all operations that can be executed by the ground system.	
Related Documents:	
Preparation Information The Ground System Operations Manual will contain the following minimum material: 1. System and Operations Overview 2. Operational Environment 3. Configuration Control 4. Nominal Operations 5. Contingency Operations 6. Maintenance Operations	
Special Preparation Instructions This CDRL is only required in accordance with Option 13 and is not part of the baseline contract.	

Title: MOC Ground System Test Plan	**CDRL No.:** Option 13-7
Reference: Mission Operations Concept Document Mission Systems Specification	
Purpose:	
Related Documents:	
Preparation Information The Ground System Test Plan shall contain the following minimum material: 1. Test methodology 2. Test resources 3. Test procedure and data management 4. Test discrepancy management 5. Test verification tracking 6. Test Documentation	
Special Preparation Instructions This CDRL is only required in accordance with Option 13 and is not part of the baseline contract.	

Title: MOC Ground System Procedures	**CDRL No.:** Option 13-8
Reference: Mission Operations Concept Document Mission Systems Specification	
Purpose: The Ground System Procedures describe all activities that are required to interact with the ground system to use and maintain it.	
Related Documents:	
Preparation Information The Ground System Procedures shall contain the following minimum material: 1. Software system overview 2. Software and database organization and structure 3. Detailed software process description 4. Software maintenance resource requirements 5. Software maintenance procedures 6. Ground system configuration process 7. Hardware system overview 8. Detailed vendor and custom equipment description 9. Hardware layout 10. Hardware corrective maintenance procedures 11. Hardware preventive maintenance procedures 12. Software and hardware configuration management procedures	
Special Preparation Instructions This CDRL is only required in accordance with Option 13 and is not part of the baseline contract.	

Title: MOC Facilities Plan	**CDRL No.:** Option 13-9
Reference: Mission Operations Concept Document Mission Systems Specification	
Purpose: The facilities plan describes the all aspects of the physical characteristics of the MOC including power redundancy, security and interface communications	
Related Documents:	
Preparation Information The Facilities Plan shall contain the following minimum material: 1. Area Layout 2. Equipment List 3. Equipment and Cabling configuration 4. Installation schedule 5. Installation Procedures and Constraints 6. Power and Environmental requirements and conditions 7. Facility Access and Security 8. Assumptions regarding expected/needed government provided equipment	
Special Preparation Instructions This CDRL is only required in accordance with Option 13 and is not part of the baseline contract.	

Title: Mission Operation Procedures	**CDRL No.:** Option 13-10
Reference: Mission Operations Concept Document Mission Systems Specification	
Purpose: The Mission Operations procedures represent the set of configuration controlled procedures for both the ground system and the observatory that are used in daily, routine, normal, or contingency situations.	
Related Documents:	
Preparation Information The Mission Operations shall contain the following minimum material: 1. Manual procedures to perform all automatic functions 2. All Observatory Command procedures 3. All Ground System procedures 4. All Contingency Procedures 5. All procedures used to communicate with, interface to, and verify elements external to the MOC.	
Special Preparation Instructions This CDRL is only required in accordance with Option 13 and is not part of the baseline contract.	